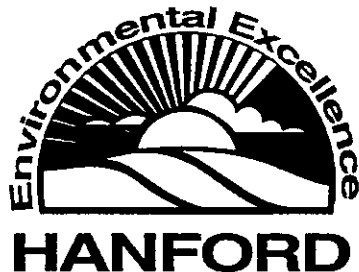


BHI-01052
Rev. 0

Description of Work for a Vadose Zone Characterization Borehole at the 216-B-2-2 Ditch



Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Bechtel Hanford, Inc.
Richland, Washington

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Author

J. M. Faurote

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Date Published

October 1997



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ACRONYMS

BHI	Bechtel Hanford, Inc.
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act</i>
DOE	U.S. Department of Energy
DOW	description of work
DQO	data quality objective
EII	Environmental Investigation Instructions
EIP	Environmental Investigation Procedures
FY	fiscal year
HSRCM	Hanford Site Radiological Control Manual
OSHA	Occupational Safety and Health Administration
OU	operable unit
QAPjP	quality assurance project plan
RCRA	<i>Resource Conservation and Recovery Act</i>
SAP	sampling and analysis plan
WAC	Washington Administrative Code
WHC	Westinghouse Hanford Company

1.0 INTRODUCTION

This Description of Work (DOW) details the characterization activities related to a proposed borehole in the 200-BP-11 Operable Unit (OU), and will serve as a guide for those performing the work. The 216-B-2-2 Ditch was selected for characterization based on the *Waste Site Grouping Report for 200 Area Soil Investigations* (DOE-RL 1997) which identified this ditch as a representative site for the Gable Mountain Pond/B-Pond and Ditches Cooling Water Group (DOE-RL 1997). Specific procedures for defined tasks are covered under the Bechtel Hanford, Inc. (BHI) *Environmental Investigations Procedures* (EIP) (BHI 1995b). The scope of work includes drilling the proposed borehole, Well ID Number B8079, to refine the conceptual model, assessing the nature and extent of subsurface contaminants, and supporting remedial action/closure decisions for the Gable Mountain Pond/B-Pond and Ditches Cooling Water Group.

In 1995 a Draft B Work/Closure Plan (DOE-RL 1995) was prepared for 200-BP-11 OU waste sites including the 216-B-2-2 Ditch. The work/closure plan provided Data Quality Objectives (DQOs), a sampling strategy, and a Quality Assurance Project Plan (QAPjP). In 1996 the 200-BP-11 Work/Closure Plan went to dispute resolution because of schedule concerns. Based on the results of the dispute resolution, a commitment was made to initiate characterization of the OU in fiscal year (FY) 1998 (scope to be determined by the 200 Area Strategy Workshop) and to prepare a 200 Area soil remediation strategy. The strategy for the 200 Areas was prepared in 1996 (DOE-RL 1996) which redefined operable units into waste site groups and defined the assessment process. Following the strategy, representative sites for each waste site group were selected for characterization in *Waste Site Grouping for 200 Areas Soil Investigations* (DOE-RL 1997). For the Gable Mountain/B-Pond and Ditch Cooling Water Group (formerly 200-BP-11), the 216-B-2-2 Ditch was selected as a representative site to be characterized. The 216-B-2-2 Ditch was selected as a representative site because it 1) was operationally typical of a ditch and contains a representative inventory of contaminants; 2) is expected to contain typical to higher levels of contamination at the head end of the ditch system, plus high levels of strontium-90 associated with a 1,000 Ci unplanned release; and 3) lies in the middle of the 216-B-2 ditch system, providing composite data for all three ditches at depth. The proposed borehole to be drilled in the 216-B-2-2 Ditch is intended to satisfy the 200-BP-11 dispute resolution commitment to initiate characterization in FY 1998 and to implement the 200 Area soil remediation strategy. The borehole data will be used to evaluate and select the remedy for all sites within the group consistent with the analogous group concept. This borehole does not represent all the characterization needed for either the 216-B-2-2 Ditch or the waste group. Except for the proposed 216-B-2-2 Ditch borehole, the 200-BP-11 Work/Closure Plan will be superseded by the Gable Mountain/B-Pond and Ditch Cooling Water Group Work Plan, which is scheduled to be issued in FY 1999. This work plan will define additional characterization needs for the waste group including the 216-B-2-2 Ditch.

1.1 DATA QUALITY OBJECTIVES

The DQO process is used to assess the amount of characterization data required, the uses of the data, and how the decisions will be made; these issues were addressed in the 200-BP-11 Work/Closure Plan (DOE-RL 1995). The Work/Closure Plan addresses the 216-B-2-2 Ditch and identifies a borehole to groundwater in the area of the 216-B-2-2 Ditch, consistent with this DOW. Data quality objectives from the Work/Closure Plan applicable to the proposed deep borehole are provided in Appendix A. Data quality objectives established in the Work/Closure Plan are applicable to this limited investigation and form the basis for the DOW and attached Sampling and Analysis Plan (SAP) (Appendix B). The DQOs are summarized in Tables 1-1 through 1-4.

1.2 BOREHOLE LOCATION AND SITE GEOLOGY

The proposed site selected for the characterization boring, Well ID Number B8079, will be at the influent end of the 216-B-2-2 Ditch (Figure 1-1, Borehole Location Map). This is the optimum location to encounter maximum levels of contamination according to the conceptual model (Figure 1-2). Within the model, the contaminants enter the ditch and are readily adsorbed to the sediments below the ditch, with lesser amounts transported the length, or to a pond. Continuous, relatively high volume flow into the ditch over a prolonged period of time can transport the contaminants to groundwater. This work scope is to assess the nature of contamination in the vadose zone or a location which is postulated to have the highest levels of contamination.

The borehole will be drilled to an estimated depth of 76.8 m (252 ft), to the water table, in the Ringold Formation Unit A gravel (moderate- to well-cemented, pebble-cobble gravel), if present. If the Elephant Mountain Member of the Columbia River Basalt Group is encountered, the drilling will be terminated. The vadose zone is primarily composed of the upper and lower glaciofluvial gravels (pebble-cobble and cobble-boulder) and an interbedded sand of the Hanford formation. These Hanford formation sediments overlie the paleosol and lacustrine silts, and/or the discontinuous Ringold Formation lower mud sequence. The paleosol and/or muds may act as a confining layer to the aquifer. Static water level is situated at the top of the Ringold Formation Unit A, if present, or the top of the basalt. Figure 1-3 is the conceptual borehole that shows the physical and chemical sampling points. Figure 1-4 is the stratigraphic column model for the northwest end of the 200-BP-11 OU upon which the drilling and sampling is based. The column indicates the relationships between lithologic units.

Figure 1-1. Location Map Showing the Location of the Proposed Borehole at 216-B-2-2 Ditch.

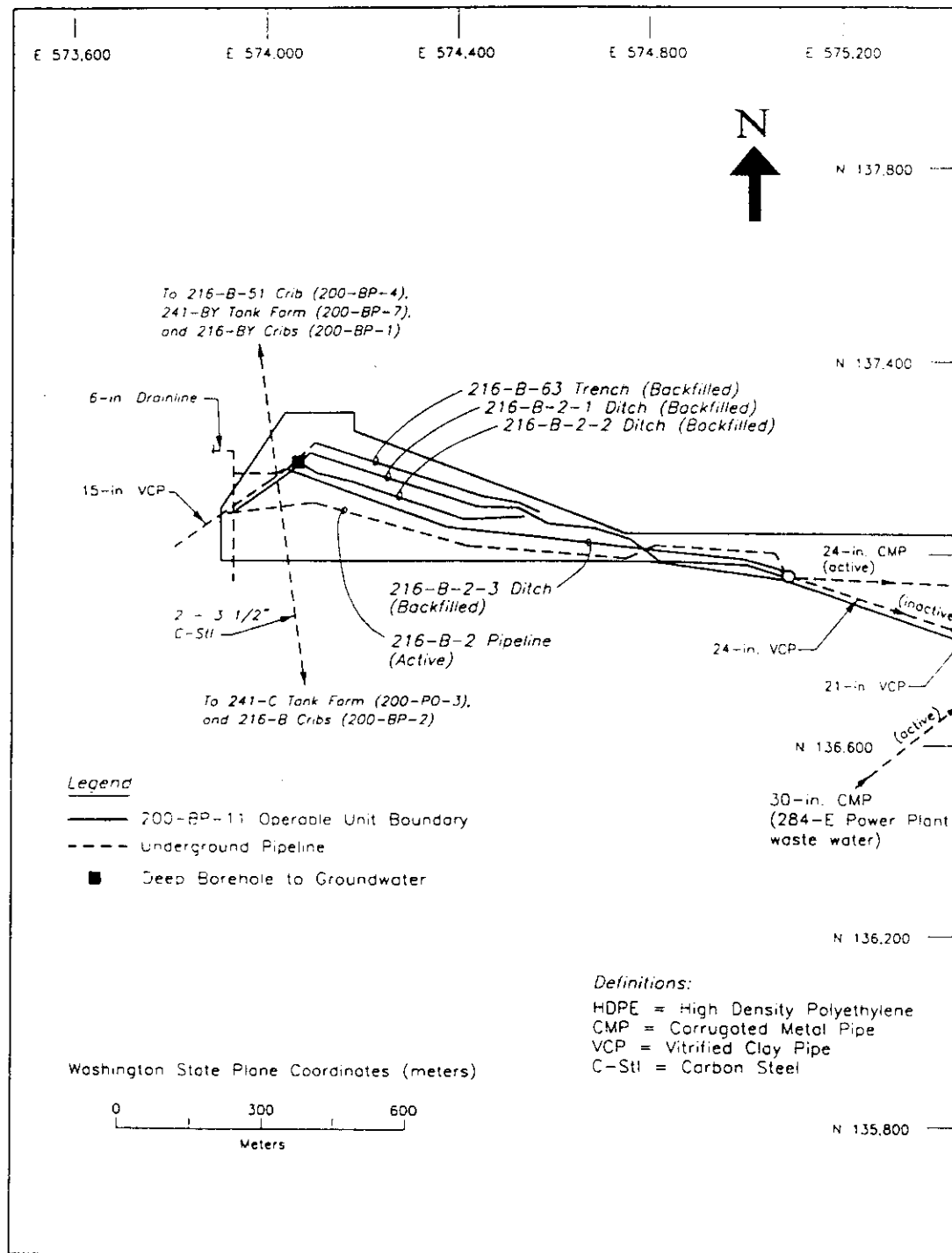


Figure 1-2. Conceptual Model of Contaminant Fate and Transport in Ditches.

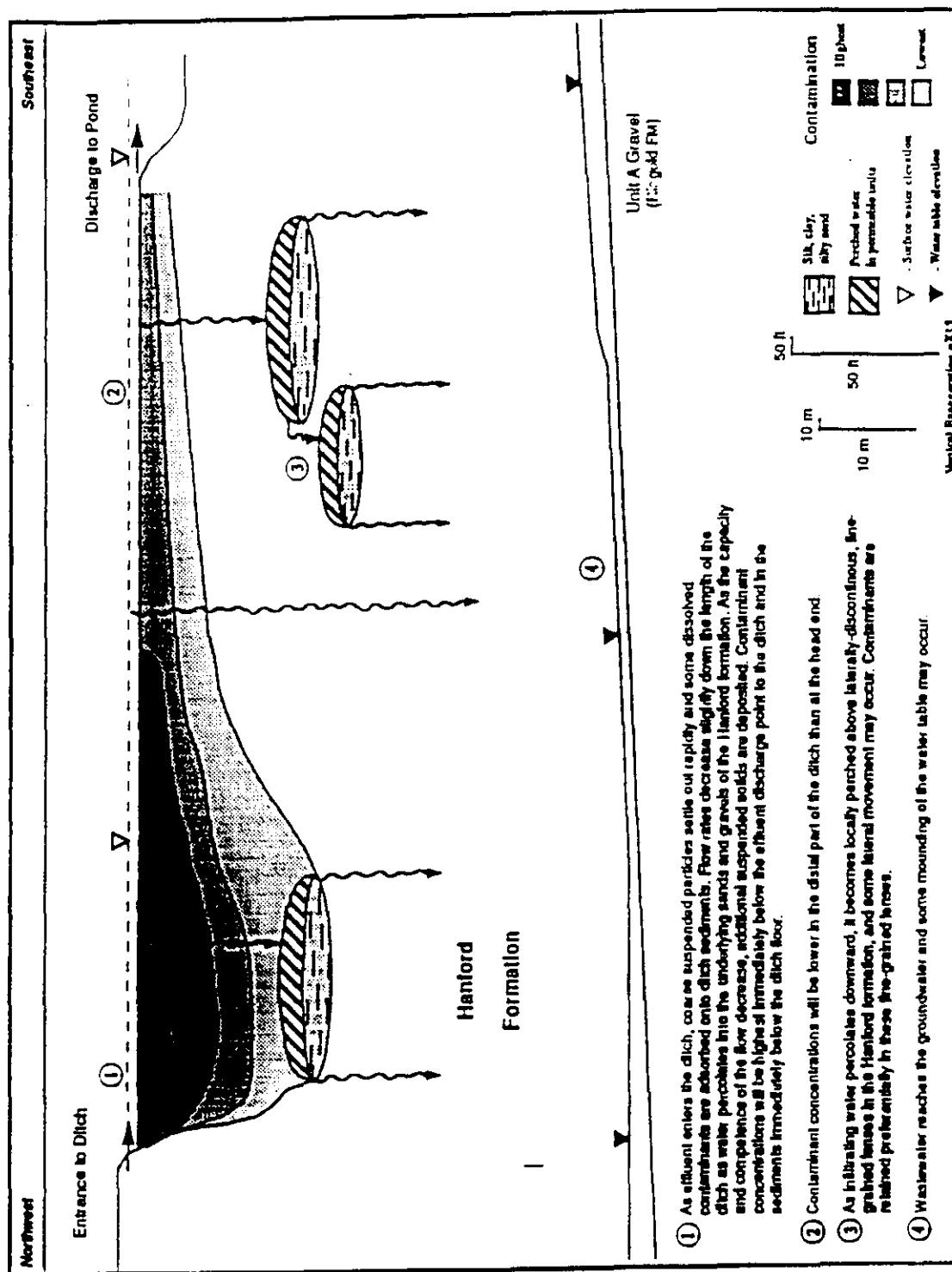


Figure 1-3. Conceptual Borehole with Proposed Physical and Chemical Sampling Points.

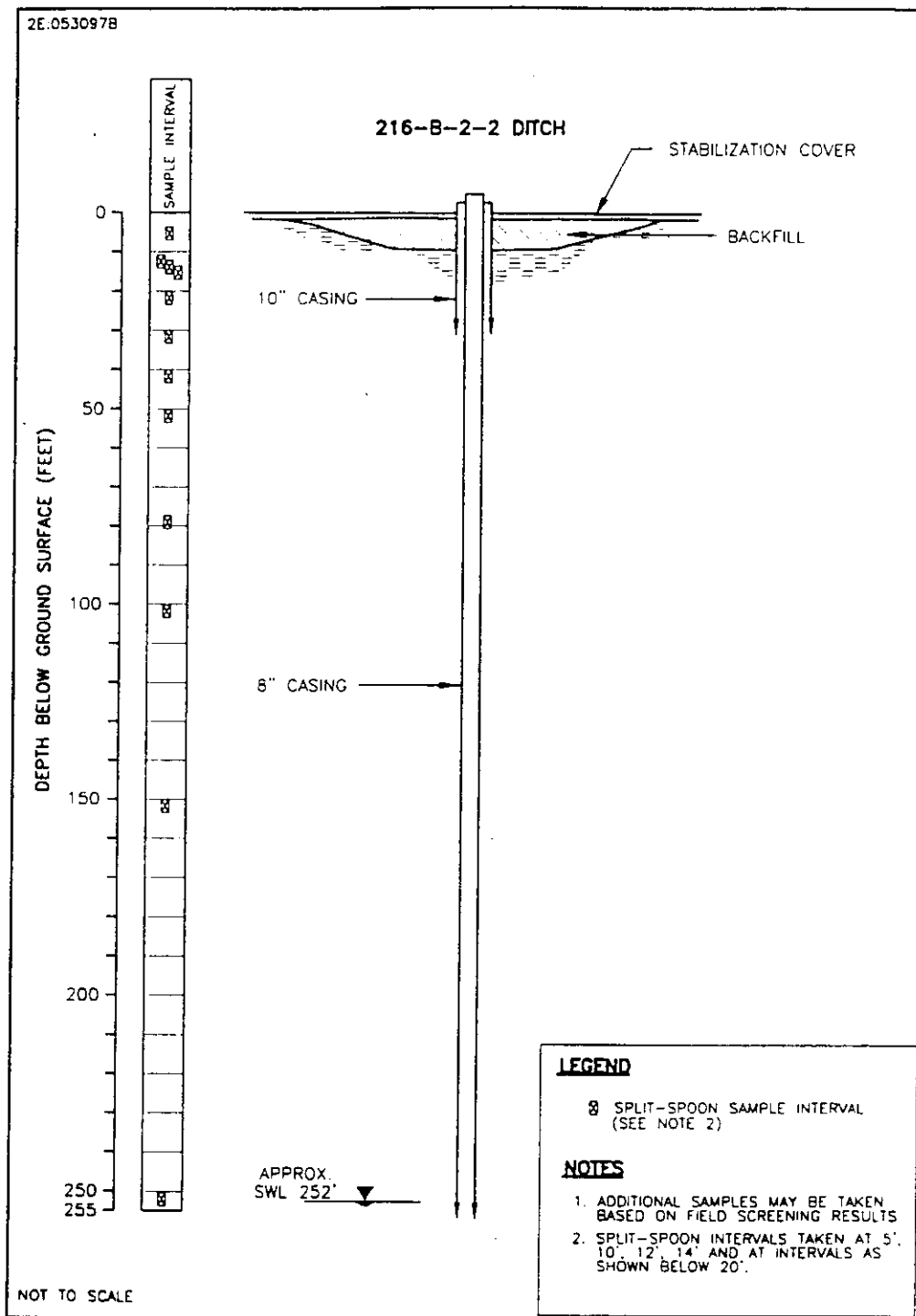
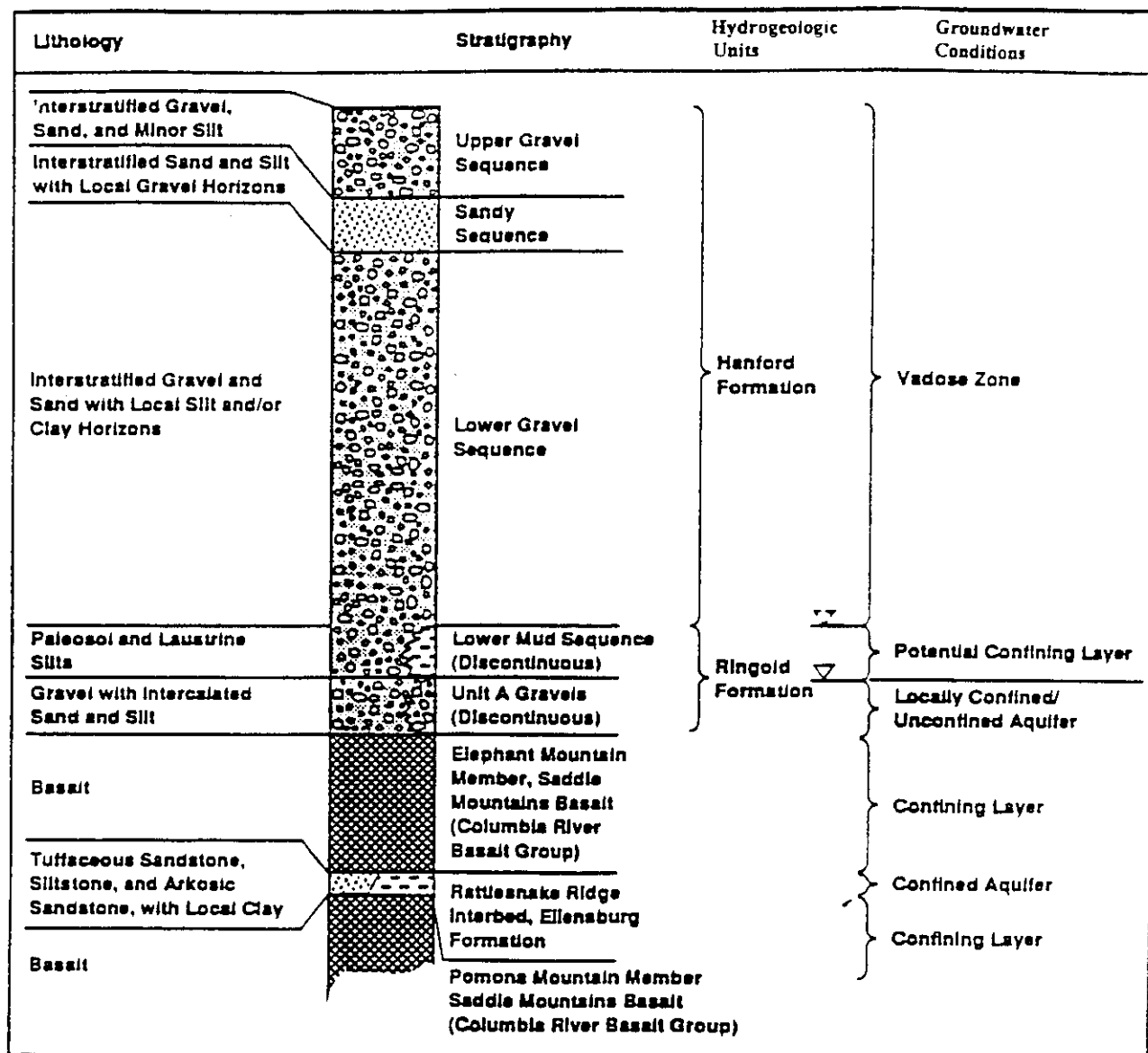
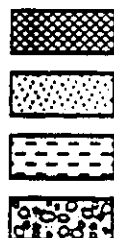


Figure I-4. Stratigraphic Column for the 200-BP-11 Operable Unit (Northwest Part).



H9310001.2



Basalt

Sand

Silt/Clay

Gravel

▽ Groundwater Table

▽ Potential Perching Layers (localized, potential perched groundwater may also be associated with fine-grained sediments of Hanford formation and Upper Ringold Unit)

Lithology, stratigraphy, and groundwater conditions based on data from Lindsey et al. (1991), and Delaney et al. (1991).

Table 1-1. Data Quality Objectives for Surface Radiological Surveys.
(Modified from DOE/RL-93-74, Draft B.)

Activity	Screen potential sampling sites for background and elevated levels of radioactivity. Screening is conducted both as normal operating procedures for the OU and as health and safety monitoring during intrusive field activities.
Objectives	Locate "hot spots" where radiation levels are twice background readings.
Prioritized Data Use(s)	Refine sampling locations to target potential zones of maximum contamination.
Appropriate Analytical Level or Implementation Guidelines	Surface radiation surveys will be carried out according to descriptions of work.
Parameters to be Obtained	Location, date, time, calibration data, and radiation level reading.
Required Detection or Measurement Limits	Surveys will follow standard operating procedures as outlined in descriptions of work.
Critical Samples or Values	Not applicable
Constraints	<ul style="list-style-type: none"> • Background readings must be taken in an uncontaminated area. • Instruments must be properly calibrated.

Table 1-2. Data Quality Objectives for Soil Sampling and Analysis for Physical, Chemical, and Radiological Sampling. (Modified from DOE/RL-93-74, Draft B.)

Activity	Collect soil samples during test pit/auger and borehole drilling and analyze samples for physical, chemical, and radiological properties.
Objectives	Soil sampling will address data needs of vertical and horizontal distribution of contaminants through chemical and radiological analysis and data needs of geologic/hydrologic characterization through physical analysis.
Prioritized Data Use(s)	The priority data uses are to support characterization of geology and hydrostratigraphy and contaminant characteristics and transport for refining the conceptual model, as well as to support the conduct of the qualitative risk assessment.
Appropriate Analytical Level or Implementation Guidelines	Samples will be collected according to procedures outlined in EIP 4.0 (BHI 1995b) and DOW.
Parameters to be Obtained	Bulk density, particle size distribution, moisture content, pH, unsaturated hydraulic conductivity, metals, volatile organics, semivolatile organics, and radionuclides.
Required Detection or Measurement Limits	Analytical detection limits and data quality objectives requirements are identified in the Quality Assurance Project Plan (Appendix C).
Critical Samples or Values	One sample from each lithologic unit encountered at a given sample location.
Constraints	Single samples can be assessed statistically only with comparison to data from previous investigations or other boreholes, or where field duplicates are collected.

Table 1-3. Data Quality Objectives for Borehole Geophysical Surveys.
(Modified from DOE/RL-93-74, Draft B.)

Activity	Perform radionuclide logging system spectral gamma and gross gamma logging on the borehole and on selected existing wells. Neutron moisture probes will be run.
Objectives	Geophysical logging of boreholes will help define hydrostratigraphy, source contributions, and nature and extent of contamination.
Prioritized Data Use(s)	The priority data uses are to support characterization of contaminant distribution and hydrostratigraphy in support of refining the conceptual model.
Appropriate Analytical Level or Implementation Guidelines	Boreholes will be logged according to <i>Environmental Investigation Instruction</i> (EII) 11.1 (WHC 1988) and descriptions of work.
Parameters to be Obtained	Depth of logging, logging speed, base calibration date, date and time of logging, gross gamma activity, and gamma spectrum.
Required Detection or Measurement Limits	Surveys will follow standard operating procedures, as identified in EII 11.1 (WHC 1988).
Critical Samples or Values	All boreholes drilled to 15.2 m (50 ft) or more should be logged with radionuclide logging system spectral gamma and gross gamma, plus a neutron moisture probe. Existing wells in the OU that lack these data also should be surveyed.
Constraints	Existing well borehole construction may affect results. Improper sealing of old wells may yield misleading data where flow of contaminated water along well casings may have deposited radionuclides.

**Table 1-4. Data Quality Objectives for Perched Water Sampling.
(Modified from DOE/RL-93-74, Draft B.)**

Activity	Sample perched water encountered in boreholes during ongoing sampling activities for chemical and radiological properties.
Objectives	Perched water sampling and analysis will support data needs for the evaluation of the vertical and horizontal extent of contamination and refinement of the conceptual and hydrostratigraphic model.
Prioritized Data Use(s)	The priority data uses are to support characterization of the vertical and horizontal extent of contamination and to refine the conceptual model.
Appropriate Analytical Level or Implementation Guidelines	Perched water sampling will be carried out under the guidance of EIP 4.1 (BHI 1995b) and descriptions of work.
Parameters to be Obtained	Volatile organics, semivolatile organics, metals, and radionuclides.
Required Detection or Measurement Limits	Analytical detection limits and data quality objectives requirements are identified in the Quality Assurance Project Plan (Appendix C).
Critical Samples or Values	One sample from each perched water zone encountered, including one unfiltered and one field filtered for metals.
Constraints	Inadequate supply of water in perched zone may limit the kinds of analyses performed and the representativeness of the sample.

2.0 GENERAL REQUIREMENTS

2.1 SAFETY AND HEALTH

Field activities will be conducted within a potentially radioactive and hazardous environment. All personnel working at the site will have OSHA 40-hour Hazardous Waste Site Worker Training, and Radiation Worker II Training as minimum entrance requirements to be defined in the site Health and Safety Plan. All work will be performed in accordance with the following:

- *Hanford Site Radiation Control Manual, Rev. 2* (HSRCM 1995)
- *As Low As Reasonably Achievable Program* (BHI 1995a)
- *Safety and Health Procedures, Volumes 1- 4* (BHI 1995h)
- *Industrial Hygiene Work Instructions* (BHI 1995g)
- *Environmental Restoration Contractor Quality Program* (BHI 1995d).

2.2 PREREQUISITES

Requirements and procedures for the 216-B-2-2 borehole activity are specified in the following documents. The drilling, data acquisition, sampling and sample shipping will adhere to the BHI EIPs found in the BHI-EE-01 (BHI 1995b); these include, but are not limited to:

- EIP 1.5 "Field Logbooks"
- EIP 1.6 "Surveying"
- EIP 1.8 "Well Characterization and Evaluation"
- EIP 1.11 "Purgewater Management"
- EIP 2.0 "Sample Event Coordination"
- EIP 3.0 "Chain of Custody"
- EIP 3.1 "Sample Packaging and Shipping"
- EIP 4.0 "Soil and Sediment Sampling"
- EIP 6.0 "Documentation of Well Drilling, Abandonment, Remediation, and Completion Operations"
- EIP 6.2 "Field Cleaning and/or Decontamination of Drilling Equipment"
- EIP 7.0 "Geologic Logging."

Other facets of the work will be covered under the:

- *Environmental, Safety, and Health Programs* (BHI 1995e)
- *Field Support Administration* (BHI-FS-01), Section 4.14, "Control of CERCLA and Other Past Practice Investigation Derived Waste" (BHI 1995f)
- *Environmental Requirements* (BHI-EE-02), Section 11.0, "Solid Waste Management" (BHI 1995c)
- *Waste Management Plan* (BHI 1997)
- *Technical Specification for Environmental Drilling Services* (BHI-SPEC-C-00008) (BHI 1995i).

In addition EIIs that will be used in the field activities include (WHC 1988):

- EII 5.5 "Laboratory Cleaning of RCRA/CERCLA Sampling Equipment"
- EII 11.1 "Geophysical Logging."

Calibration standards and frequency will be in accordance with the manufacturer's standards unless otherwise superseded by Hanford Site requirements.

3.0 SAMPLING AND FIELD ACTIVITIES

This section summarizes the field soil screening, drilling, sampling, geophysical logging, and completion/abandonment requirements for the proposed borehole. Additional details are provided in the *Sampling and Analysis Plan* (SAP) (Appendix B).

3.1 SITE PREPARATION

A surface radiological survey will be conducted to release an area in the vicinity of the proposed site for well B8079 for drill pad construction, and the shortest overland route from existing roads.

3.2 DRILLING

All drilling will be via a method approved by BHI, and in accordance with the *Washington Administrative Code* (WAC), Chapter 173-160 (Ecology 1990), and will conform to the *"Technical Specifications for Environmental Drilling Services"* (BHI 1995i). Cleaning and decontamination mandates will be covered through EIP 6.2, "Field Cleaning and/or Decontamination of Drilling Equipment" (BHI 1995b).

If a cable tool drill is used the borehole will be advanced using the drive barrel technique. In general, the drive barrel will be constructed so that the maximum advance will be no more than 0.76 m (2.5 ft) before the barrel must be emptied at the surface. Hard-tool drilling will not be used except in cases where boulders and/or cemented or consolidated materials prohibit borehole advancement. When using the hard-tool technique, the addition of water to the borehole is undesirable, and must be approved in advance by the site technical representative. All volumes of water added, and the corresponding depth, will be recorded by the site geologist on the borehole log.

The borehole will be drilled to the top of the water table, expected to be at a depth of approximately 76.8 m (252 ft) below ground surface. The presence of water-saturated soils will indicate the end of the borehole, and will be determined by the site geologist. Three strings of casing will be telescoped to the proposed depth, to minimize transport of contaminants in the vadose zone from the drilling operations. The casing sizes will be of sufficient size to accommodate a split spoon to the bottom of the borehole. Detailed borehole information is in the 216-B-2-2 Borehole Data Sheet (Appendix D). Split-spoon diameter requirements will be based on total sample volume requirements. Downsizing of the casing will be commensurate with the expected decrease in contamination levels with depth. Field screening of the drill cuttings and samples will be used to determine the depths where the casing should be downsized. Spectral gamma-ray and gross gamma logging will be conducted prior to telescoping of casings. Neutron moisture logging will be completed on the borehole to assess the vertical moisture distribution in the soil column. Actual conditions during drilling may warrant changes; the changes may be implemented after consultation with, and the approval of, the task lead and the site technical representative.

Waste generated from the drilling will be handled according to BHI-FS-01, *Field Support Administration*, Section 4.14, "Control of CERCLA and other Past Practice Investigation Derived Waste, Rev. 1, (BHI 1995f), and BHI-EE-10, *Waste Management Plan* (BHI 1997). A plan with waste handling requirements will be developed for the activity. Radioactive materials will be put into appropriate containers, labeled as directed, and stored onsite in a radiological controlled area, if required. Chain-of-Custody documentation and procedure EIP 3.0 (BHI 1995b) will be applied to samples stored onsite until they are shipped for analyses or dealt with according to the plan.

Geologic materials removed from the borehole will be logged by the site geologist on a borehole log as specified in EIP 7.0, "Geologic Logging" (BHI 1995b). The log includes, but is not limited to, the lithologic description, sample code and depth, Hanford Environmental Information System numbers for each sample interval, field screening results, as well as relevant and/or pertinent events, and general information about the borehole. Recording and reporting of drilling activities, and the abandonment plan, will conform to EIP 6.0 (BHI 1995b), "Documentation of Well Drilling, Abandonment, Remediation, and Completion Operations" as well as all applicable WAC codes.

3.3 SOIL SCREENING

All samples and/or cuttings from the borehole will be field screened for evidence of radionuclides and volatile organics by the radiological control technician, industrial health technician, field geologist, or other qualified personnel. Radioactivity screening of the soils removed will assist in the selection of supplementary sample intervals. Field screening instrumentation will be maintained consistent with the manufacturer's specifications and other approved procedures. The site geologist will record all field screening results in the borehole log. Field screening, methodology and instrumentation is described in detail in the SAP located in Appendix B.

3.4 SAMPLING

Samples for chemical, radionuclide, and physical properties will be collected at generally specified intervals throughout the borehole (Figure 1-3). Analytes will consist of a modified Appendix IX groundwater monitoring list, which is detailed in the attached SAP (Appendix B). Characterization samples will be taken from split-tube inner liners; archive samples may be taken directly from the drive barrel in accordance with EIP 4.0, "Soil and Sediment Sampling" (BHI 1995b) or may be acquired from the remnants of the chemical/radiological and physical properties sampling. Additional samples may be taken at the discretion of the well site geologist, based on lithologic changes, and/or the activity levels as defined in the SAP.

Chemical, radiological, and physical properties analysis require a large volume of material. If insufficient sample volume is attained, the chemical/radiological portion of the sample will take precedence over the physical properties samples. Should additional materials be required, a split spoon may be re-driven. A portion of the physical properties sample, and the archival samples may be obtained from the drive barrel. Chemical split spoons are scheduled to be taken at 1.5, 3.0, 3.7, 4.3, 6.1, 9.1, 12.2, 15.2, 22.9, 30.5, and 45.7 m (5, 10, 12, 14, 20, 30, 40, 50, 75, 100, and 150 ft) depth bgs, and immediately above the water table, if possible.

Should perched water be encountered during drilling, the water will be sampled immediately and should be analyzed for the same suite of analytes as the soils (Table B-1, Appendix B), plus fluoride, C-14, and tritium. A bailer will be used to sample the water. No purging is required as the water is freshly entered into the bore and the quantity of water may be limited.

3.5 GEOPHYSICAL LOGGING

High-resolution spectral gamma-ray, neutron (if available), and gross gamma log data will be collected for the entire length of the borehole prior to abandonment. In addition, when it has been determined that the casing should be telescoped to the next smaller size, the gamma sonde(s) will be run before the next string of casing is installed. Data from these sondes will be used to assess contaminant distribution and stratigraphy. All geophysical logging will be in accordance with EII 11.1, "Geophysical Logging" (WHC 1988), or other approved procedures. Applicable detection limits, analytical methods, plus accuracy and precision requirements are

defined in the documents governing borehole logging. The site geologist will indicate all geophysical surveys on the geologic log, and include the depth interval of initial and repeat runs.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance/Quality Control requirements are defined in the SAP (Appendix B) and the Quality Assurance Project Plan (Appendix C).

5.0 SCHEDULE

Drilling is expected to commence during mid-November 1997 and to be completed by the end of the same month.

6.0 REFERENCES

- BHI, 1995a, *ALARA Program*, Bechtel Hanford, Inc., Richland, Washington.
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- BHI, 1995d, *Environmental Restoration Contractor Quality Program*, BHI-QA-01, Bechtel Hanford, Inc., Richland, Washington.
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APPENDIX A

**200-BP-11 OPERABLE UNIT DATA QUALITY OBJECTIVE
DECISIONS/AGREEMENTS/COMMITMENTS
APPLICABLE TO THE PROPOSED BOREHOLE**

These DQOs were taken from the 200-BP-11 Work Plan/Closure Plan (DOE/RL-93-74, Draft B, Appendix D). The DQOs were modified to reflect the deep borehole to be completed at the 216-B-2-2 Ditch, and to incorporate the planning and data requirements.

200-BP-11 Operable Unit Data Quality Objectives Decisions/Agreements/Commitments

As of October 26, 1994, there have been two Data Quality Objective (DQO) processes held amongst the Department of Energy (Richland Office), Washington State Department of Ecology (Ecology), and U.S. Environmental Protection Agency (EPA) in preparation of a coordinated RCRA Facility Investigation/Corrective Measure Study (RFI/CMS) for the 200-BP-11 Operable Unit and the closure/postclosure of the RCRA TSD units contained within the operable unit.

The first DQO process spanned from October 1993 to March 1994 and included the DQOs for preparation of the 200-BP-11 Operable Unit and 216-B-3 Main Pond Work/Closure Plan (DOE/RL-93-74), Volume 1, Draft A. The operable unit at the time of the first DQO process consisted of ten waste management units: the 216-B-3 Main Pond; the 216-B-3A, 216-B-3B and 216-B-3C Expansion Ponds; the 216-B-3-1, 216-B-3-2, and 216-B-3-3 Ditches; the 216-E-28 Contingency Pond; and Unplanned Releases UN-200-E-14 and UN-200-E-92. The 216-B-3 Main Pond and 216-B-3-3 Ditch are united to form one RCRA TSD unit called the 216-B-3 Main Pond, and the 216-B-3A, 216-B-3B, and 216-B-3C Expansion Ponds are combined to form another RCRA TSD unit called the 216-B-3 Expansion Ponds.

The second DQO process was finalized in October 1994 and took about one month to complete. This process occurred because of the addition of five waste management units to the operable unit: the 216-A-29 Ditch; the 216-B-63 Trench; and the 216-B-2-1, 216-B-2-2, and 216-B-2-3 Ditches. The 216-A-29 Ditch and the 216-B-63 Trench are individual RCRA TSD units.

1. Assumptions.

- a. The 216-B-3A, 216-B-3B, and 216-B-3C Expansion Pond TSD unit will be clean closed as described in the *216-B-3 Expansion Ponds Closure Plan*. DOE/RL-89-28, Rev. 2.
- b. Quality Assurance Project Plans (QAPPs) and Sampling and Analysis Plans (SAPs) will meet both RCRA TSD and RCRA Past-Practice DQOs.
- c. The 200-BP-11 Operable Unit meets the Model Toxics Control Act (MTCA) definition of Industrial; thus, the future land use for the 200-BP-11 Operable Unit is assumed to be Industrial.
- d. The risk assessment methodology from the Hanford Site Baseline Risk Assessment Methodology (HSBRAM) will be utilized for the 200 Area Industrial scenario. The risk assessment may need to be updated at a later date to assess risks based on a residential scenario.
- e. Waste might be left in place in the operable unit and/or the TSD units within the operable unit.
- f. RCRA TSDs within the operable unit may be clean closed, modified clean closed, and/or closed as landfills under Washington State regulations (WAC 173-303).
- g. The same cleanup standards will apply to the TSD and the Past-Practice waste management units within the operable unit.

2. Sampling Approach.

An incremental approach will be taken toward characterization of the waste site and this borehole. Phase 1 sampling will be engineered biased (i.e., sample in locations expected to have highest contaminant concentrations). Phase 1 sampling data from this initial investigation will be evaluated (distribution, frequency, validation, variability, contamination levels, regulatory guidelines, etc.) to aid in the assessment of characterization activities following Phase 1.

3. Phase 1 Sampling Objective. Below are the key objectives of Phase 1 sampling.

- a. Assess site contamination to Industrial Cleanup Standards (MTCA C for dangerous waste and HSBRAM [Hanford Site Baseline Risk Assessment Methodology] for radionuclides). However, the analyses provided in support of characterization will have practical quantitation limits below the Residential

Cleanup Standards (MTCA B for dangerous waste and HSB RAM for radionuclides) or Site Background.

- b. Provide data for a qualitative/quantitative risk assessment.

Note that groundwater sampling is beyond the scope of the 200-BP-11 characterization activities, but groundwater contamination and monitoring will need to be addressed prior to closure of the TSDs. Additionally, prior to borehole drilling, groundwater personnel will be consulted to assess their need for groundwater monitoring wells.

- 4. The agreed-to potential Contaminants of Concern (COC), Practical Quantitation Limits (PQL), Analytical Methods, and Cleanup Standards for the operable unit are provided in Attachment 1. The agreements that are inherent to Attachment 1 include:
 - a. Analytical methods will be SW-846 with summary deliverables for all data packages. As data packages are selected for validation (Item 12), they will be upgraded to stand-alone deliverable standards. (Note that upgrading of the data packages from a summary deliverable to a stand-alone deliverable will take approximately three weeks.)
 - b. Non-detects will be reported as less than the PQL or MDL concentration number. Other calculations can be reported if requested.
 - c. The following compounds do not have readily-available methods and have a low probability of being present and will be identified and estimated in concentration as Tentatively Identified Compounds (TICs): 1-butanol (8240), ethyl ether (8240), formaldehyde (8270), acetate (8270), and kerosene (8270).
 - d. Tributylphosphate (TBP) is not on any standard analyte list. The laboratory will calibrate for this compound during the 8270 analysis and will quantitate each sample for this analyte. PQLs will be determined and reported for this analyte. This is a requirement for whatever lab is performing the analyses.
 - e. Hydrazine will not be analyzed because it will have decomposed.
 - f. Nitrate and nitrite will be examined for all samples using both Method 300 (ion chromatography with a 48-hour holding time) and Method 353 (28-day holding time). (Method 300 is also used for sulfate/sulfite and, therefore, there is no cost increase to report nitrite/nitrate and compare to the Method 353 results).
 - g. Total chromium will be analyzed using Method 6010 and assumed as chromium VI.

5. Supplementary Analyses.

All samples will be analyzed for a “modified” 40 CFR 264 Appendix IX groundwater monitoring list. The modified Appendix IX list for the 200-BP-11 operable unit is defined as the Appendix IX analytical methods, minus analyses for phosphorous pesticides (Method 8140), herbicides (Method 8150), dioxins (Method 8280), and non-halogenated volatile organics (Method 8015). The non-halogenated volatile organics (e.g., kerosene) will be analyzed as TICs using Method 8240B and 8270B.

6. Sampling Design and Approach.

- a. The sampling design for the first round of sampling is provided in Attachment 2.
- b. Round One of the Field Investigation — Sampling will be performed to assess the question: Are dangerous constituents or radionuclide contamination present in concentrations greater than Industrial Cleanup Standards (per MTCA C and HSB RAM Industrial, respectively)?

7. Field Screening and Sampling Criteria.

- a. All samples and cutting will be field-screened for evidence of volatile organics and radionuclides. Volatiles will be screened by the field geologist or other qualified personnel using an organic vapor monitor. Radionuclides will be screened by alpha- and gamma-counting instruments. Either a FID (flame ionization detector) or PID (photoionization detector) can be used to detect volatile organics.
- b. The sampling criteria for radionuclide screening is twice background. The sampling criteria for volatile organic screening is 5 ppm. The intent of these criteria is to trigger assessment for sampling. The field geologist will make this assessment (i.e., if there are many locations above the criteria, the field geologist will determine when and where the samples should be taken).

Note that specific surface samples are not planned since interim stabilization has already occurred, and therefore, field screening and/or rad surveys will be used to evaluate potential surface sampling sites.

- c. Local area background radiation will be determined by taking a background reading using the above instruments at a pre-agreed local site in the field (e.g., the Contingency Pond). The local area background will be measured on freshly-disturbed surface soil, holding the instruments less than 2.5 cm (1 in.) from the soil. The background readings may be taken daily depending on meteorology (e.g., inversions, wind, etc.).

8. Sampling Locations at Depth.

- a. Sampling from the ground surface to the ditch sediments: Because the waste management unit to be sampled is interim stabilized (backfilled), this item describes the sampling scenario from the ground surface to the ditch sediments. If the surface radiation is not at least twice background, then a sample will be taken between two to six feet below the surface to support a risk assessment. If the pond/ditch sediments are within this two- to six-foot range, then a sample will be taken from the ditch sediments. Also, if a lithological change is encountered, a sample will be taken at the lithologic interface as determined by the field geologist. Samples to be taken below the sediments are described next.
- b. Sampling below the ditch sediments: Samples below the sediments will be taken at lithological interfaces as determined by the field geologist, hot spots, and/or at predetermined depths.
 - i. Lithological Changes. Estimates of lithologic changes will be made using current stratigraphy maps. The field geologist will make the determination of significant lithologic changes for sampling.
 - ii. Hot Spots. The field geologist or other qualified person will make the determination as to when to sample a hot spot. Typically, the first indication of a hot spot (as defined in 7b above) will be sampled.
 - iii. Pre-established Depths. Pre-established sampling depths will be used in the absence of lithologic interfaces and hot spots, and apply below the sediment surfaces only (i.e., the 0 datum is the ditch sediments).

Pre-established sampling depths are as follows:

 - Deep Groundwater Borehole — 2, 5, 10, 20, 30, 40, 50, 75, 100, and 150 ft., with an additional sample, if possible, above the water table (250 ft.).

9. Perched Water Samples.

If perched water is encountered in the boring, one sample will be taken. However, for inorganics, two samples will be collected per well: one will be unfiltered, and a second will be filtered through a 0.45 micron filter onsite before being bottled and preserved. These samples will also be analyzed for the modified Appendix IX list, plus fluoride, C-14, and tritium.

10. Physical Sample Analyses.

Samples will be taken at major lithologies within boreholes and may be analyzed for physical properties such as:

- Bulk density.
- Particle size distribution.
- Moisture content.
- pH.
- Unsaturated hydraulic conductivity.

When possible, the physical samples will be archived until chemical analytical results are obtained and evaluated.

11. Priority of Analyses.

Field screening for radiation will be performed on the loose soil from the drill casing.

At the discretion of the field geologist, when there is sufficient sample size, VOA samples will always be taken first. Other samples will be taken in a sequence which will yield best results.

If there is insufficient sample size, then the following will be the analytical priority:

<u>RCRA Past-Practice and TSD Units</u>	<u>Perched Water</u>
Rad	Rad
Metals	Metals
Semi-VOA	VOA
VOA	Semi-VOA
General Chemistry	General Chemistry
Physical	Physical

12. Data Validation.

Initially, summary deliverables will be requested for all data packages. After evaluation of the analytical results, the data packages for validation will be prioritized based on the samples with the highest contaminant concentrations. The data packages selected for validation will then be upgraded with stand-alone deliverables. Regardless of the analytical results, at least 20 percent of the data packages will be validated. The overall

progress of data package validation will be communicated to DOE, Ecology, and EPA for their concurrence.

Attachment 1
Comparison of Contaminant PQLs, Hanford Site Background and MTCA "C" Values
(Page 1 of 3)

Contaminant	Hanford Site Background ^(a) (mg/kg)	PQL	MTCA (mg/kg)				Analytical Method
			Method B		Method C		
			Non-carcinogen	Carcinogen	Non-carcinogen	Carcinogen	
Inorganics							
Arsenic	7.65	0.3	2.40E+01	5.90E-01	1.05E+03	7.60E+01	ICP/6010
Barium	148	1	5.60E+03		2.45E+05		ICP/6010
Beryllium	1.65	1	4.00E+02	2.33-01	1.75E+04	3.10E+01	ICP/6010
Bismuth	(c)	10					ICP/6010
Boron	(c)	10	7.20E+03		3.20E+05		ICP/6010
Cadmium	(c)	2	8.00E+01		3.50E+03		ICP/6010
Chromium-VI (a)	22.3	2	4.00E+02		1.75E+04		ICP/6010
Copper	24.7	2	3.20E+03		1.40E+05		ICP/6010
Iron	35600	10					ICP/6010
Lead	12.2	10					ICP/6010
Manganese	7780	1	1.12E+04		4.90E+05		ICP/6010
Mercury	0.7	0.3	2.40E+01		1.05E+03		AA/7471
Nickel	21.6	4	1.60E+03		7.00E+04		ICP/6010
Potassium	2520	500					ICP/6010
Selenium	(c)	25	4.00E+02		1.75E+04		GF/AA/6010
Silver	1.52	20	2.40E+02		1.75E+04		ICP/6010
Tin	(c)	50	4.80E+02		2.10E+06		ICP/6010
Uranium (d)	0	1.0 µg/g	2.40E+02		1.05E+04		LAB SOP
Vanadium	96.4	2	5.60E+02		2.45E+04		ICP/6010
Zinc	73.3	2	2.40E+04		1.05E+06		ICP/6010

CLP=Contract Laboratory Procedure

IC=Ion Chromatography

VOA=Volatile Organic Analysis

GC/MS=Gas Chromatograph/Mass Spectrometry

GC/MS=Gas Chromatograph/Mass Spectrometry

Note: MTCA "C" risk based concentrations based on HQ=1 and ICR=1E-05

(a) Cr-VI will be analyzed as total Cr

(b) Listed quantitation limits are for water. Quantitation limits are highly matrix dependent and will be higher in soils.

(c) Hanford Site Background values not established.

(d) Uranium (soluble salts) toxicity values for chemical (not radioactive) characteristics. See radionuclide tables for rad values.

(e) Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes, DOE/RI-92-24, Rev. 3

Attachment 1

Comparison of Contaminant PQLs, Hanford Site Background and MTCA "C" Values
(Page 2 of 3)

Contaminant	Hanford Site Background ^(a) (mg/kg)	PQL	MTCA (mg/kg)				Analytical Method
			Method B		Method C		
			Non-carcinogen	carcinogen	Non-carcinogen	carcinogen	
Other Inorganics							
Acetate (from acetic acid)	(c)	50					8270 TIC
Ammonia	17.3	0.5					350.1
Cyanide (total)	(c)	0.5	1.60E+03		7.00E+04		9010
Fluoride (water only)	2.93	100 µg/l (b)	3.20E+03		1.40E+05		1C/300
Nitrate	56.9	1	1.30E+05		5.60E+06		1C/300 & 353
Nitrate (as N)	(c)	1	8.00E+03		3.50E+05		1C/300 & 353
Sulfate (from sulfuric acid)	566	5					1C/300
Volatile Organics							
Acetone	(g)	10	8.00E+03		3.50E+05		VOA/8240
Butanol, 1-	(g)	5000	8.00E+03		3.50E+05		8260 TIC
Butanone, 2- (MEK)	(g)	10	4.80E+04		2.10E+06		VOA/8260
Carbon tetrachloride	(g)	5	5.60E+01	7.69E+00	2.46E+03	1.00E+03	VOA/8260
Chloroform	(g)	5	8.00E+02	1.64E+02	3.50E+04	2.13E+04	VOA/8260
Ethyl ether	(g)	5	1.60E+04		1.75E+06		8260 TIC
Methylene chloride	(g)	5	4.80E+03	1.33E+02	2.10E+05	1.83E+04	VOA/8260
Toluene	(g)	5	1.60E+04		7.00E+05		VOA/8260
Trichloroethane, 1,1,1-	(g)	5	7.20E+03		3.20E+05		VOA/8260
Trichloroethane, 1,1,2-	(g)	5	3.20E+02	1.80E+01	1.40E+04	2.30E+03	VOA/8260
Semivolatile Organics							
Formaldehyde	(g)	N/A		3.30E+01		4.40E+03	Cannot analyze as TIC under 8270
Hydrazine	(g)			3.33E+01		4.33E+01	Will not be analyzed
Kerosene	(g)	5000					8270 TIC
PCBs	(g)	21 or 33		1.30E+01		1.70E+01	8080 (PCBs 1242-21; all others = 33)
Tributyl phosphate	(g)	500	4.00E+02		1.80E+04		8270 (special calibration)
Naphthalene	(g)	660	3.20E+02		1.40E+04		8270

CLP=Contract Laboratory Procedure

IC=Ion Chromatography

VOA=Volatile Organic Analysis

GC/FID=Gas Chromatograph Flame Ionization Detector

Note: MTCA "C" risk based concentrations based on HQ=1 and ICR=1E-05

(a) Cr-VI will be analyzed as total Cr

(b) Listed quantitation limits are for water. Quantitation limits are highly matrix dependent and will be higher in soils.

(c) Hanford Site Background values not established

(d) Uranium (soluble salts) toxicity values for chemical (not radioactive) characteristics. See radionuclide tables for rad values.

(e) Hanford Site Background, Part 1, Soil Background for Nonradioactive Analytes, DOE/RL-92-24, Rev. 3

(f) Assumed to be zero

Attachment 1
Comparison of Contaminant PQLs, Hanford Site Background and MTCA "C" Values
(Page 3 of 3)

Contaminant	Hanford Site Background ^(c) (pCi/g)	INDUSTRIAL HSBRAM (pCi/g)					Analytical Method
		AIDA	Oral SF I/pCi	Soil Ingestion by Children/Adults	Oral SF I/pCi	Dust Inhalation by Adults	
Radionuclides		(pCi/g)					
Gross Alpha	(c)	10.00					Gas Proportional
Gross Beta	24.07	15.00					Gas Proportional
Cesium-137 (Ba-137m)	1.51	0.10	2.80E-11	2.50E+02	1.90E-11	1.10E+04	Gamma Spectrometry
Cobalt-60	0.0104	0.05	1.50E-11	4.60E+02	1.50E-10	1.30E+03	Gamma Spectrometry
Europium-152	(c)	0.10	2.10E-12	3.30E+03	1.10E-10	1.80E+03	Gamma Spectrometry
Europium-154	0.0427	0.10	3.00E-12	2.30E+03	1.40E-10	1.40E+03	Gamma Spectrometry
Europium-155	0.0723	0.10	4.50E-13	1.50E+04	1.80E-11	1.10E+04	Gamma Spectrometry
Uranium-235 (Pa-231)	(c)	1.00	1.60E-11	4.30E+02	2.50E-08	8.00E+00	Gamma Spectrometry
Americium-241	(c)	1.00	2.40E-10	2.90E+01	3.20E-08	6.30E+00	Alpha Spectrometry
Curium-244	(c)	1.00	1.60E-10	4.30E+01	2.20E-08	9.10E+00	Alpha Spectrometry
Neptunium-237	(c)	1.00	2.20E-10	3.10E+01	2.90E-08	6.90E+00	Alpha Spectrometry
Plutonium-238	0.00648	1.00	2.20E-10	3.10E+01	3.90E-08	5.10E+00	Alpha Spectrometry
Plutonium-239/240	0.0366	1.00	2.30E-10	3.00E+01	3.90E-08	5.30E+00	Alpha Spectrometry
Plutonium-241	(c)	15.00	3.60E-12	1.90E+03	2.30E-10	8.70E+02	Liquid Scintillation
Thorium-228	(c)	1.00	5.50E-11	1.30E+02	7.80E-08	2.60E+00	Alpha Spectrometry
Thorium-230	(c)	1.00	1.30E-11	5.30E+02	2.90E-08	6.90E+00	Alpha Spectrometry
Thorium-232	1.47	1.00	1.20E-11	5.80E+02	2.80E-08	7.10E+00	Alpha Spectrometry
Uranium-233/234	1.23	1.00	1.60E-11	4.30E+02	2.70E-08	7.40E+00	Alpha Spectrometry
Uranium-235	0.153	1.00	1.60E-11	4.30E+02	2.50E-08	8.00E+00	Alpha Spectrometry
Uranium-236	(c)	1.00	1.50E-11	4.60E+02	2.50E-08	8.00E+00	Alpha Spectrometry
Uranium-238	1.18	1.00	2.80E-11	2.50E+02	5.20E-08	3.80E+00	Alpha Spectrometry
Iodine-129	(c)	2.00	1.90E-10	3.60E+01	1.20E-10	1.70E+03	Beta Counting
Strontium-90 (Y-90)	0.247	1.00	3.60E-11	1.90E+02	6.20E-11	3.20E+03	Beta Counting
Technetium-99	(c)	15.00	1.30E-12	5.30E+03	8.30E-12	2.40E+04	Beta Counting
Selenium-79	(c)	10.00	5.80E-12	1.20E+03	6.00E-12	3.30E+04	Beta Counting
Samarium-151	(c)		1.10E-13	6.30E+04	8.70E-12	2.30E+04	No known method
Carbon-14 (water only)	(c)	200 pCi/l	9.00E-13	7.70E+03	6.40E-15	3.10E+07	Liquid Scintillation
Tritium (H-3) (water only)	(c)	400 pCi/l	5.30E-14	1.30E+05	7.80E-14	2.60E+06	LAB SOP

HSBRAM - Hanford Site Baseline Risk Assessment methodology (DOE-RL 1993).

Risk-based concentrations at incremental cancer risk level of 1E-06 for an industrial scenario based on assumptions in the HSBRAM, Rev. 2.

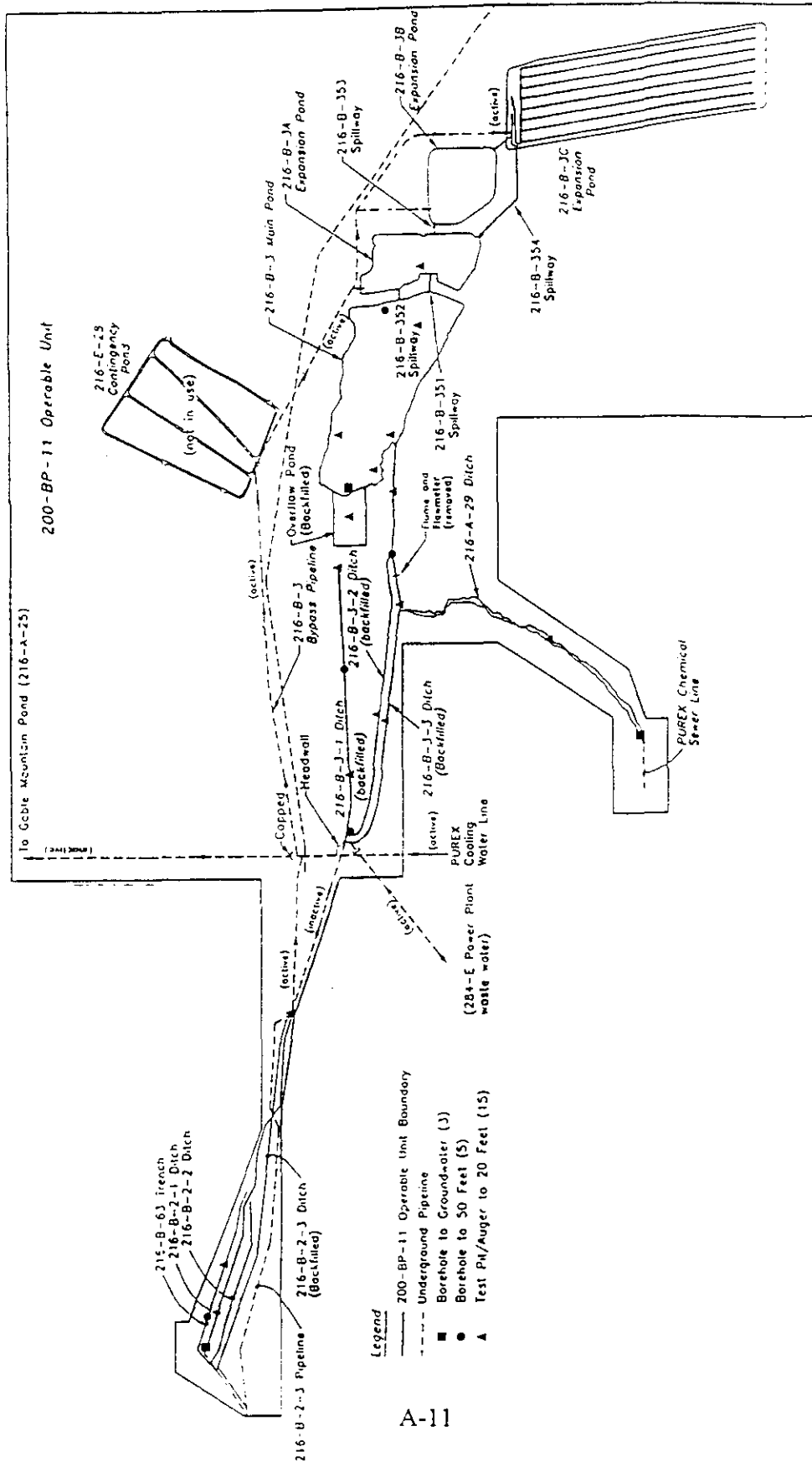
MDA - Minimum Detectable Activities

Oral Slope factors from Health Effects Assessment Summary Tables (HEAST, EPA 1992)

(c) Hanford Site Background values not established

(f) Hanford Site Background Part 2, Soil Background for Radionuclides, DOE/RL-96-12, Rev. 0

Attachment 2 200-BP-11 Operable Unit Data Quality Objectives Decisions/Agreements/Commitments



APPENDIX B
SAMPLING AND ANALYSIS PLAN FOR THE 216-B-2-2 DITCH

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ACRONYMS

ASTM	American Society for Testing and Materials
bgs	below ground surface
BHI	Bechtel Hanford, Inc.
DOE	Department of Energy
DOW	description of work
DQO	data quality objectives
Ecology	Washington State Department of Ecology
EIP	Environmental Investigations Procedures
ERC	Environmental Restoration Contractor
HEIS	Hanford Environmental Information System
ICP	inductively coupled plasma
NaI	Sodium Iodide
nCi/g	nano-curies per gram
ppm	parts per million
pCi/g	pico-curies per gram
Pu	plutonium
QAPjP	Quality Assurance Project Plan
RCF	Radiological Counting Facility
RCT	radiological control technician
RL	Richland Operations Office
RWP	Radiation Work Permit
TBD	to be determined
VOA	volatile organics analysis
μ Ci/g	micro-curies per gram

1.0 INTRODUCTION

This sampling and analysis plan defines procedures to be used for collecting and handling samples to be obtained from the 216-B-2-2 Ditch characterization borehole (B8079), and identifies requirements for field and laboratory measurements. The rationale and strategies for the sampling and analyses, and a description of the project and site background information are summarized in the description of work (DOW) and are detailed in the 200-BP-11 Work Plan/Closure Plan, Draft B (DOE-RL 1995). Soil (and perched water, if encountered) samples will be collected from the borehole and analyzed for chemical, radiological, and physical properties. Depending on the analytical criteria, samples will be collected using a split-spoon sampler or will be collected from the drive barrel and/or drill cuttings. The primary purpose of collecting and analyzing samples from the 216-B-2-2 Ditch characterization borehole is to assess the vertical distribution of contaminants through chemical and radiological analyses and to characterize the geohydrology of the vadose zone through physical sampling. These data will be used to refine the conceptual model and support remedial action/closure decisions for the Gable Mountain/B Pond Waste Group (DOE-RL 1997).

2.0 QUALITY ASSURANCE PROJECT PLAN

The supporting Quality Assurance Project Plan (QAPjP) is attached as Appendix C to the DOW and was developed as part of the 200-BP-11 Work Plan/Closure Plan, Draft B (DOE-RL 1995, Appendix E). The selection of analytical parameters, laboratory arrangements, borehole location, field measurement and sampling techniques, sampling equipment selection, and other quality assurance measures are based on the sampling objectives summarized in the main body of the DOW and the 200-BP-11 Work Plan/Closure Plan, Draft B (DOE-RL 1995). Data quality objectives (DQO) were developed as part of the 200-BP-11 Work Plan/Closure Plan effort and are summarized in the DOW. Clarification of QAPjP requirements or any deviations are discussed in Section 3.0.

3.0 FIELD SAMPLING PLAN

Sample collection techniques, as detailed in this plan, have been tailored to the goals of the sampling event and the individual characteristics of this site. The basis for all soil sampling is Environmental Investigation Procedures (EIP) 4.0, "Soil and Sediment Sampling" (BHI 1995) and the 200-BP-11 Work Plan/Closure Plan, Draft B (DOE-RL 1995). The sampling objectives and the pertinent site contaminant characteristics are summarized in the DOW and detailed in the 200-BP-11 Work Plan/Closure Plan, Draft B (DOE-RL 1995). Discrete soil samples will be collected using split-spoon samplers and grab samples from the contents of the drive barrel. If perched water is encountered during drilling, a water sample will be collected with a bailer and analyzed for chemical and radiological contaminants of concern.

3.1 SAMPLE LOCATIONS, FREQUENCIES AND ANALYTICAL PARAMETERS

Analytical parameters were selected based on a review of the site data during DQO meetings with U. S. Department of Energy (DOE), Richland Operations Office (RL), Washington State Department of Ecology (Ecology), and the U.S. Environmental Protection Agency (EPA). Results of the DQO meeting are documented in the 200-BP-11 Work Plan/Closure Plan, Draft B, Appendix D (DOE-RL 1995) for the B Pond and Ditch System, and are summarized in the DOW. The general sampling approach and sample locations include the following:

- Samples and cuttings from the borehole will be field screened for evidence of radionuclides and volatile organics. This information will assist in the field selection of split-spoon sample intervals.
- Split-spoon sampling to collect discrete soil samples at 5, 10, 12, 14, 20, 30, 40, 50, 75, 100, and 150 ft-depths below ground surface (Figure B-1), with an additional sample from the ditch fill and, if possible, above the water table (≈ 252 ft). Actual sample intervals may vary. Based on the judgement of the site geologist, additional/alternative split-spoon samples may be collected at hot spots (above twice background for radioactivity and/or 5 ppm organic vapors) and/or at significant lithologic changes. These samples will be analyzed for chemical and radiological contaminants of concern (Table B-1) and physical properties. If sufficient split-spoon sample material remains, archive samples will be collected. The drive barrel may also be used to collect archive samples.
- If perched water is encountered during drilling, water samples will be collected, if possible, and analyzed for radiological and chemical contaminants of concern as defined in Table B-1. In addition, if perched water is present, the soil sampling interval should be modified to collect at least one chemical/radiological and physical sample, if possible.

Deviations from Table B-1 methods may include using inductively coupled plasma (ICP) method 6010 for arsenic and selenium, which is expected to reduce analytical costs and sample volume and meet required detection limits. No method is available to analyze samarium-151.

Detection limits, analytical methods, holding times, and container/volume requirements are shown in Tables B-2 and B-3. Volume and container requirements will be finalized by a Sample Authorization Form in accordance with EIP 2.0, "Sample Event Coordination" (BHI 1995).

3.2 SAMPLING METHODS

3.2.1 Soil Screening

All samples and cuttings from the borehole will be field screened for evidence of radionuclides and volatile organics by the radiological control technician (RCT), field geologist, or other qualified personnel. Radioactivity will be screened using gamma (NaI) and low-level alpha and beta detectors (field instruments). Prior to initiating drilling, a local area background reading

will be taken using the above instruments at a background site to be selected in the field. Volatile organics will be screened using either a flame ionization or photoionization detector.

The action level for radionuclide screening is twice background, and the action level for volatile organic screening is 5 ppm. Intervals above these action levels will be referred to as "hot spots" and will be assessed for sampling by the field geologist. Field screening instruments will be used, maintained, and calibrated consistent with the manufacturer's specifications and other approved procedures. The field geologist will record field screening results on the borehole log.

3.2.2 Soil Sampling

3.2.2.1 General Sampling Requirements and Methods. Chemical/radionuclide, physical properties, and archive samples will be collected from the borehole as shown in Figure B-1 and/or discussed below. The sampling will be performed in accordance with EIP 4.0, "Soil and Sediment Sampling" (BHI 1995), using a split-spoon sampler and analyzed for the parameters listed in Table B-2. If insufficient soil is retrieved in the split spoon to satisfy the volumetric requirements for sample analysis, the split spoon may be re-driven or additional sample material retrieved from the drive barrel. The chemical/radiological portion of the sample will take precedence over physical properties samples, which take precedence over archival samples.

The drive barrel can be used to obtain physical properties samples when insufficient samples are obtained with the split spoon, although use of the split-spoon sampler may be required to collect physical properties samples for bulk density, moisture content, and permeability measurements. An entry will be made in the borehole log identifying the sample collection method and depth intervals using the codes presented in Table B-4. All depths will be recorded to the nearest 0.025 m (0.10 ft).

Drilling personnel will not overdrive the sampling device. The split-spoon and liners will be decontaminated before use according to EIP 4.0 and 6.2, "Soil and Sediment Sampling" and "Field Cleaning and/or Decontamination of Drilling Equipment" (BHI 1995). Prior to sampling, slough in the borehole will be removed to the greatest extent possible.

3.2.2.2 Analytical Soil Sampling. Each borehole will be sampled at specific intervals using the split-spoon sampler. The split-spoon samplers will be equipped with four separate stainless steel liners for chemical/radiological samples. Lexan or stainless steel liners may be used to collect physical properties samples. Before the head and shoe are removed from the split-spoon sampler, drilling personnel are required to mark the sampler (with chalk or other suitable technique) to ensure that the sampling personnel or geologist can distinguish the top and bottom of the sampler. All split-spoon sampling depths will be referenced to the maximum depth the split spoon is driven. All depths will be recorded to the nearest 0.025 m (0.10 ft). Liners within the sampler will be designated alphabetically A, B, C, and D. Liner "A" will be located next to the shoe of the sampler, while liner "D" is located near the head of the sampler.

The initial split-spoon sample interval for borehole B8079 will be located to sample the soil that has been placed over the ditch for interim stabilization. The initial sample will be collected at approximately 0.6 to 2.0 m (2 - 6 ft) bgs in the fill material. The second split-spoon sample

interval will be located to sample the ditch base/vadose zone soil interface (Figure 1). This depth is currently projected to be 3.7 m (12 ft) bgs, but may be reassessed using Geoprobe™ data. Drill pad construction will likely change these sample depths. A final determination of the initial sample depths will be made prior to the start of drilling. The site geologist will need to use professional judgment and field screening data to determine the appropriate intervals for obtaining samples at depths greater than 3.7 m (12 ft) bgs.

The field screening criteria established in Section 3.2.2 will be used to ensure that the most contaminated material from each sampling interval is submitted for analysis. This will involve screening the ends of the split spoon after the drive head and shoe are removed. The split spoon will be opened and the liners surveyed. If an interval is identified that is more contaminated than surrounding material, it will be separated from adjacent liners and a sample will be obtained. If insufficient material is present to satisfy all the bottle requirements for analysis, a composite sample will be obtained by mixing material from above and below the contaminated interval. A Radiation Work Permit (RWP) will specify radiological criteria for when the split spoon can be opened outdoors in a Radiological Control Area or when it must be opened inside a glovebox. If the radiological contamination exceeds the RWP, the split spoon will be lowered back inside the well casing until health and safety documentation can be reviewed and revised. All split-spoon samples shall have a representative portion submitted to the Environmental Restoration Contractor (ERC) Radiological Counting Facility (RCF), 222-S Laboratory, or other suitable onsite laboratory for total activity analysis. This will be utilized for sample pre-shipment characterization. Chemical and radiological samples with a total activity of less than the established laboratory criteria will be analyzed at an offsite laboratory. Those samples exceeding the laboratory criteria will be repackaged to meet laboratory dose rate criteria or routed to a designated onsite laboratory for analysis. Onsite and offsite laboratories will be identified prior to initiating field activities and will be mutually acceptable to ERC Sample Management and the Task Lead.

Samples collected for physical analysis and unconditionally released by the RCT as nonradioactive will be submitted to physical properties testing laboratory. Radioactive physical samples that do not exceed 25 mrem will be submitted a laboratory capable of handling radiological material, if available. Samples exceeding 25 mrem will be stored at a temporary radioactive storage area until a determination is made if they will be analyzed. All sample containers will be labeled with applicable borehole number, sampling date, time, depth interval to the nearest foot (physical samples only), Hanford Environmental Information System (HEIS) number, requested analysis, and the sampler's initials.

Splits of sample intervals may be obtained for the Washington State Department of Ecology (Ecology) from the borehole. Ecology will be present and work in conjunction with the samplers to obtain sample splits. Ecology will assume responsibility that the samples are properly collected. Shipping requirements will be determined based on the total activities, if required. Ecology will ship any of their samples that are not radioactive. The ERC will assist Ecology on a case-by-case basis in the shipment of radioactive samples. Prior to providing Ecology samples that are radioactive, laboratory documentation specifying U.S. Nuclear Regulatory Commission licenses must be provided to the ERC for the Ecology laboratory.

3.2.2.2.1 Chemical and Radionuclide Analysis. Soil samples for characterizing chemical and radionuclide contaminants will be collected from the borehole as discussed in Section 3.1. Chain-of-custody documentation will be prepared by the sampling scientist. Container and volume requirements for chemical and radiological samples are presented in Table B-3. If full sample volume requirements cannot be met, the volume obtained will be recorded in the sampling scientist's logbook per EIP 1.5, "Field Logbooks" (BHI 1995) and analyzed according to the following priority:

1. Radionuclides
2. Metals
3. Semi-volatile organics analysis (VOA)
4. VOA
5. General Chemistry.

3.2.2.2.2 Physical Property Analysis. Samples for determining the physical parameters of the vadose zone will be collected from the borehole as discussed in Section 3.1. Sample volume and container recommendations for physical properties analyses are to be determined (Table B-3). Four sample intervals will be collected with the split-spoon sampler, coincident with the four chemical split-spoon sampling intervals discussed in Section 3.2.3.2.

All physical samples will undergo a limited set of physical analyses (Type A samples), but a sample from each major lithology (as determined by the field geologist) within the borehole will undergo a much larger set of physical analyses (Type B samples). The samples will be analyzed using American Society for Testing and Materials methods, if available (ASTM 1993).

The following physical analyses will be run on Type A samples:

- Bulk density
- Particle density
- Particle size distribution
- Moisture content
- pH
- CaCO_3 content.

The following physical analyses will be run on Type B samples:

- The five Type A analyses listed above
- Saturated hydraulic conductivity
- Unsaturated hydraulic conductivity
- Matric potential and soil moisture retention curves (unsaturated samples)
- Cation exchange capacity
- Organic carbon content
- If possible, Eh.

The samples must be collected and transported in a manner that preserves the original moisture content and soil structure. Type A samples will be collected in sample sleeves and/or "moisture

tins." The sample in the sleeve must be in an undisturbed state and the sleeve must be as full as possible. The physical property samples will be analyzed using the methods identified in Table B-2.

Tests for bulk density, porosity, permeability, moisture content, and moisture retention are expected to require at least one full, and relatively undisturbed, split-spoon liner, and one filled 400-g moisture tin. Material larger than 7.62 cm (3 in.) will be removed from samples before placing in the sample container. The borehole summary report will document if material larger than 7.62 cm (3 in.) was removed.

3.2.2.3 Perched Water Sampling. If perched water is encountered in sufficient quantity during borehole drilling, perched water will be sampled with a decontaminated bailer. Perched water sampling will be conducted according to the protocols listed in EIP 4.1, "Groundwater Sampling" (BHI 1995) except purging, and temperature, pH, turbidity and electrical conductivity monitoring during sampling. Because the borehole will not be completed as a monitoring well, these sampling constraints are not considered to be appropriate.

Perched water samples will be analyzed for chemical and radionuclide contaminants as discussed in Section 3.1. For anions and metals analyses, both unfiltered and filtered (through a 0.45-micron filter onsite before being bottled and preserved) samples will be collected and analyzed. Samples will be handled as groundwater samples and will be labeled with the well designation, an indication of the filtration, and the date of collection. Chain-of-custody documentation will be prepared by the sampling scientist. Container and volume requirements for chemical and radiological samples are presented in Table B-3. If full sample volume requirements cannot be met, the volume obtained will be recorded in the sampling scientist's logbook per EIP 1.5, "Field Logbooks" (BHI 1995) and analyzed according to the following priority:

1. Radionuclides
2. Metals
3. VOA
4. Semi-VOA
5. General Chemistry.

3.2.2.4 Archive Sampling. All material removed from a borehole will be identified and described by the site geologist and summarized on the borehole log. Archive samples should be collected each time a physical sample is collected, provided sufficient material is available. As a minimum, remaining portions of physical samples that have been unconditionally radiologically released will be archived. Additional archive samples may be collected by the field geologist. Archive samples will be stored onsite until ready for disposal as investigation derived waste.

Each archive sample will be labeled with the appropriate sample depth interval (to the nearest foot), date, and time the sample was obtained. Chain-of-custody documentation as detailed in EIP 3.0, "Chain of Custody" (BHI 1995), will be prepared by the site geologist. Each archive interval will be logged in the field logbook and the borehole log. Samples will be packaged to

minimize breakage and spillage by archiving the samples in sealed 1-L wide-mouth jars or double-contained plastic bags.

3.2.3 Geophysical Logging

High-resolution spectral gamma-ray, gross gamma-ray and neutron moisture logs will be collected from the characterization borehole. The characterization borehole will be logged with high-resolution spectral gamma-ray and gross gamma-ray sondes prior to telescoping of casing during drilling. In addition, a final high-resolution spectral gamma-ray log and gross gamma-ray log will be collected over the entire length of the characterization borehole prior to abandonment. The site geologist will record all geophysical logging runs performed at the characterization borehole including the depth interval of initial and repeat runs. All geophysical logging will be performed in accordance with Environmental Investigations Instruction (EII) 11.1. "Geophysical Logging" (WHC 1988), or other approved procedures.

High-resolution spectral gamma-ray logs will be used to determine and confirm the vertical distribution and concentration of all gamma-emitting radionuclides of concern down to the low pCi/g range, and other radionuclides, such as ^{238}Pu , $^{239/240}\text{Pu}$, and uranium, in the nCi/g to $\mu\text{Ci/g}$ range. Neutron moisture logs will be used to assess and confirm (soil moisture measurements from physical samples) the vertical distribution of moisture in the soil column beneath the ditch.

3.3 FIELD QUALITY CONTROL

Special care should be taken to prevent cross-contamination of sampling equipment, sampling bottles, or anything else that could potentially compromise the integrity of the samples. Particular care will be exercised to avoid the following common ways in which cross contamination or background contamination may compromise soil samples:

- Improper storage or transportation of sampling equipment and sample containers,
- Contaminating the equipment or sample bottles by setting them on or near potential contamination sources such as uncovered ground,
- Handling bottles or equipment with dirty hands,
- Improper decontamination of equipment before sampling or between sampling events.

Internal quality control samples shall be collected based on the QAPjP located in Appendix C of the DOW and from the 200-BP-11 Work Plan/Closure Plan, Draft B, Appendix E (DOE-RL 1995). Specifically, the following field quality control samples shall be collected.

1. A minimum of 5% of the total collected samples for the borehole shall be duplicated, or one field duplicate shall be collected for every 20 samples, whichever is greater from the split-spoon sampler, and analyzed per Table B-1. The term "shift" applied in the QAPjP is defined as the borehole. Duplicate samples shall be retrieved from the same sampling

location using the same equipment and sampling technique and shall be placed into two identically prepared and preserved containers. All field duplicates shall be analyzed independently by the laboratory.

2. Split and blind samples are not required.
3. Field blanks shall be collected at the same frequency as field duplicate samples. Field blanks shall consist of pure deionized distilled water, transferred into a sample container at the site and preserved with the reagent specified for the analytes of interest. Field blanks are used as a check on reagent and environmental contamination and shall be collected at the same frequency as field duplicate samples.
4. Equipment blanks shall be collected at the same frequency as field duplicate samples where applicable, and are used to verify the adequacy of sampling equipment decontamination procedures. The field geologist may request that additional equipment blanks be taken. Equipment blanks shall consist of pure deionized distilled water washed through decontaminated sampling equipment and placed in containers identical to those used for actual field samples.
5. The VOA trip blanks shall accompany each batch (cooler) of sample containers shipped and shall consist of pure deionized distilled water added to one clean sample container. Trip blanks shall be returned unopened to the laboratory and are prepared as a check on possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions. The trip blank shall be analyzed for volatile organic compounds only.

A summary of field quality control samples expected to be taken is provided in Table B-5. The sampling shall be documented in the sampling logbook per EIP 1.5, "Field Logbooks" (BHI 1995).

3.4 SAMPLE MANAGEMENT

3.4.1 Sample Custody

A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples (cooler) shipped to any laboratory in accordance with EIP 3.0, "Chain of Custody" (BHI 1995). The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Chain-of-custody procedures will be followed throughout the sample collection, transfer, analysis, and disposal to ensure that the integrity of samples is maintained. Each time responsibility for custody of the samples changes, the new and previous custodians will sign the record and denote the date and time. A copy of the signed record will be made by the sampler any time samples are delivered to a laboratory.

A custody seal (evidence tape) shall be affixed to the lid of each sample jar. The container seal will be inscribed with the sampler's initials and the date sealed. For any sample jars collected

inside the glovebox and "bagged-out." the evidence tape may be affixed to the seal of the bag to demonstrate no tampering has occurred. This will eliminate problems associated with contaminated soils adhering to the custody tape while inside the glovebox.

3.4.2 Sample Containers and Preservatives

Level I EPA precleaned sample containers will be used for soil samples collected for chemical and radiological analysis. Container sizes may vary depending on laboratory-specific volumes needed to meet analytical detection limits. If, however, the dose rate on the outside of a sample jar exceeds levels acceptable by an offsite laboratory, the sampling lead and task lead can send smaller volumes to the laboratory. Preliminary container types and volumes are identified in Table B-3.

3.4.3 Sample Shipping

The outside of each sample jar will be surveyed by the RCT to be free of smearable surface contamination. In addition, the RCT will measure the radiological activity on the outside of the sample container (through the container) and will mark the container with the highest contact radiological reading in either disintegrations per minute or mrem/h as applicable. Any sample jars exhibiting radiological activity will be labeled with the word "Radioactive" in accordance with U.S. Department of Transportation requirements. Unless prequalified, all samples will have total activity analysis done by the RCF, 222-S Laboratory, or other suitable onsite laboratory, prior to shipment, to select proper packaging, marking, labeling, and shipping paperwork, and to verify that the sample can be received by the offsite analytical laboratory in accordance with the laboratory acceptance criteria. Samples with activities greater than 10 mR/h may not be accepted by the off-site laboratory. Samples exceeding this limit could only be accepted on a case-by-case basis if advance notice and special arrangements are made before shipment.

3.4.4 Field Documentation

This section describes the procedures to be followed for sample identification, field logbook entries, and chain-of-custody documentation for samples.

3.4.4.1 Sample Identification. The HEIS database will be used to track the sample and laboratory data obtained during this characterization. Prior to initiating field activities, a block of HEIS sample numbers will be issued to the sampling organization for this project in accordance with EIP 2.0, "Sample Event Coordination" (BHI 1995). Each chemical/radiological and physical properties sample will be identified and labeled with a unique HEIS sample number. The sample location and corresponding HEIS numbers will be documented in the sampler's field logbook.

Each sample container will be labeled with the following information using a waterproof marker on firmly affixed, water-resistant labels:

- HEIS number
- Sample collection date/time

- Name/initials of person collecting the sample
- Analysis required
- Preservation method if applicable.

3.4.4.2 Field Sampling Log. All information pertinent to field sampling and analysis will be recorded in bound logbooks in accordance with EIP 1.5, "Field Logbooks" (BHI 1995). The sampling team will be responsible for recording all relevant sampling information including, but not limited to, the information listed in Appendix A of EIP 1.5. Entries made in the logbook will be dated and signed by the individual who made the entry.

3.5 DECONTAMINATION AND TRANSPORT OF EQUIPMENT

All sampling-related equipment that comes into direct contact with the soil sample will be decontaminated in accordance with EIP 4.0 and 6.2, "Soil and Sediment Sampling" and "Field Cleaning and/or Decontamination of Drilling Equipment" (BHI 1995), prior to use. All equipment will be handled in a manner that will minimize cross-contamination between sample locations and depth intervals. Any components of the split-spoon sampler, such as the drive head and outer split tubes, need only a soap and water decontamination. When transporting or storing cleaned sampling equipment, it will be protected in a manner that minimizes the potential for contamination. Cleaned sampling equipment will be wrapped in foil and may be stored securely at the field location.

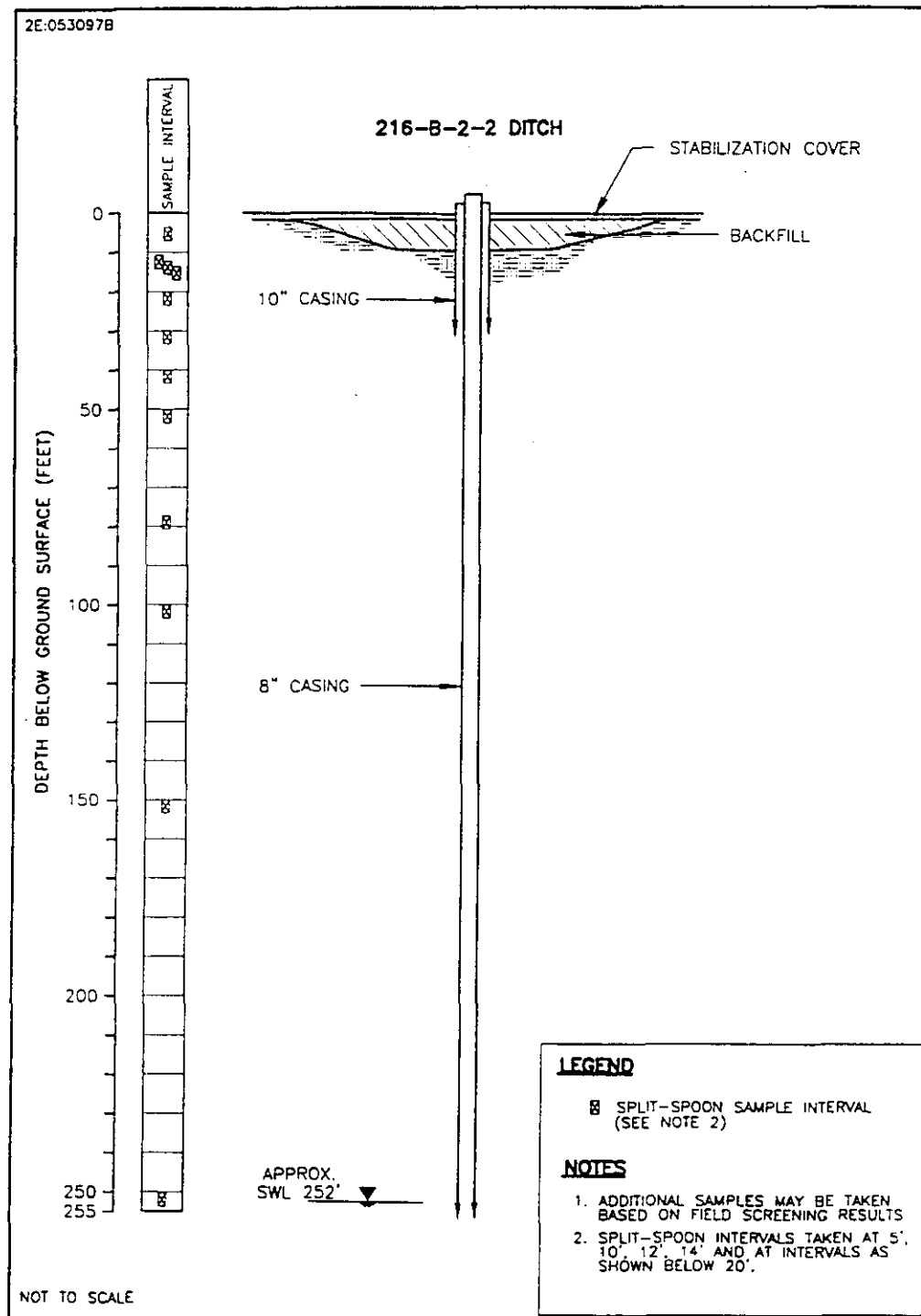
After sample collection, equipment used for sampling will be field decontaminated with nonphosphate soap and water per EIP 6.2, "Field Cleaning and/or Decontamination of Drilling Equipment" (BHI 1995). Sampling equipment that comes directly in contact with sample media will be precleaned in accordance with EIP 5.5, Laboratory Cleaning of RCRA/CERCLA Sampling Equipment.

4.0 REFERENCES

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Figure B-1. Borehole Sample Collection Intervals.



**Table B-1. Target Analytes and Analytical Methods Taken from DOE-RL 1995
(Table 5-7). (Sheet 1 of 4)**

Analyte ^a	Analytical technique/method ^b	Practical quantitation limits (nonrad) or minimum detection limits (rad) ^c	Comments
METALS			
Arsenic	GFAA/7060	0.3	
Barium	ICP/6010	1	
Beryllium	ICP/6010	1	
Bismuth	ICP/6010	TBD	
Boron	ICP/6010	10	
Cadmium	ICP/6010	2	
Chromium-VI	ICP/6010	2	
Copper	ICP/6010	2	
Iron	ICP/6010	10	
Lead	ICP/6010 (or 7421)	10 (or 0.3)	
Manganese	ICP/6010	1	
Mercury	AA/7471	0.1	
Nickel	ICP/6010	4	
Potassium	ICP/6010	500	
Selenium	GFAA/6010 (or 7740)	25 (or 0.3)	
Silver	ICP/6010	20	
Tin	ICP/7870	50	
Vanadium	ICP/6010	2	
Zinc	ICP/6010	2	
IONS			
Acetate	Semi-VOA/8270	TBD	Analyzed as a TIC
Ammonia (ammonium)	IC/350.2	30	
Cyanide	Colorimetric/CLP Metals/9010	0.8	
Nitrate	IC/300 and 353	6	
Nitrite	IC/300 and 353	100	
Sulfate	IC/300	150	

**Table B-1. Target Analytes and Analytical Methods Taken from DOE-RL 1995
(Table 5-7). (Sheet 2 of 4)**

Analyte ^a	Analytical technique/method ^b	Practical quantitation limits (nonrad) or minimum detection limits (rad) ^c	Comments
ORGANICS			
Acetone	VOA/8240	10	
Butanol, 1-	VOA/8240	TBD	Analyzed as a TIC
Butanone, 2- (MEK)	VOA/8240	10	
Carbon Tetrachloride	VOA/8240	5	
Chloroform	VOA/8240	5	
Ethyl Ether	VOA/8240	TBD	Analyzed as a TIC
Methylene Chloride	VOA/8240	5	
Trichloroethane, 1,1,1-	VOA/8240	5	
Trichloroethane, 1,1,2-	VOA/8240	5	
Toluene	VOA/8240	5	
Formaldehyde	Semi-VOA/8270	TBD	Analyzed as a TIC
Kerosene	Semi-VOA/8270	5,000	
PCBs	Semi-VOA/8080	33	
Tributyl Phosphate	Semi-VOA/8270	TBD	
Napthalene	Semi-VOA/8270	660	Special calibration required
RADIONUCLIDES			
Gross Alpha	Gas Proportional	--	
Gross Beta	Gas Proportional	--	
Cesium-137	Gamma Spectrometry/ D3649M	0.1	Measured by counting Ba-137m
Cobalt-60	Gamma Spectrometry/ D3649M	0.05	
Europium-152	Gamma Spectrometry/ D3649M	0.1	
Europium-154	Gamma Spectrometry/ D3649M	0.1	

**Table B-1. Target Analytes and Analytical Methods Taken from DOE-RL 1995
(Table 5-7). (Sheet 3 of 4)**

Analyte ^a	Analytical technique/method ^b	Practical quantitation limits (nonrad) or minimum detection limits (rad) ^c	Comments
RADIONUCLIDES (cont.)			
Europium-155	Gamma Spectrometry/D3649M	0.1	
Uranium-235 (Pa-231)	Gamma Spectrometry/D3649M	1.0	Most samples measured by counting Pa-231
Americium-241	Alpha Spectrometry/Am-01	1.0	
Curium-244	Alpha Spectrometry/907.0M	1.0	May also use gamma spectrometry
Neptunium-237	Alpha Spectrometry/907.0M	1.0	
Plutonium-238	Alpha Spectrometry/Pu-02	1.0	
Plutonium-239/240	Alpha Spectrometry/Pu-02	1.0	
Plutonium-241	Alpha Spectrometry/Pu-02	15.0	
Thorium-228	Alpha Spectrometry/	TBD	
Thorium-230	Alpha Spectrometry/	1.0	
Thorium-232	Alpha Spectrometry/	1.0	
Uranium-233/234	Alpha Spectrometry/U	TBD	Most U-233/234 samples counted by measuring Pa-231m
Uranium-235	Alpha Spectrometry/U	1.0	Most U-235 samples measured by counting Pa-231
Uranium-236	Alpha Spectrometry/	TBD	
Uranium-238	Alpha Spectrometry/U	TBD	
Iodine-129	Beta Counting/902.0M	2.0	
Strontium-90 (Y-90)	Beta Counting/SR-02	1.0	
Technetium-99	Beta Counting/TC-01M	15.0	Measured by counting Y-90
Selenium-79	Beta Counting/	5.0	
Samarium-151	Beta Counting/	TBD	
ADDITIONAL ANALYTES FOR WATER SAMPLES ONLY			
Fluoride	IC/300	51	Water only
Carbon-14	Liquid Scintillation/C-01	50	Water only
Tritium (H-3)	Liquid Scintillation/906.0	400	Water only

**Table B-1. Target Analytes and Analytical Methods Taken from DOE-RL 1995
(Table 5-7). (Sheet 4 of 4)**

GFAA = Graphite Furnace Atomic Adsorption
ICP = Inductively Coupled Plasma
AA = Atomic Adsorption
VOA = Volatile Organics Analysis
TIC = Tentatively Identified Compound
IC = Ion Chromatography
CLP = Contract Laboratory Program
TBD = To be determined
M = method modified to include extraction from the solid medium; extraction method is matrix and laboratory specific

"Prescribed Procedures for Measurement of Radioactivity in Drinking Water" (EPA 1980a)

"Test Methods for Evaluating Solid Waste" (SW 846) Third Edition (EPA 1994b)

"Methods for Chemical Analysis of Water and Waste" (EPA 1983b)

"Radionuclide Method for the Determination of Uranium in Soil and Air" (EPA 1980b)

"EML Procedures Manual" (DOE/EML 1990)

"Eastern Environmental Radiation Facility RadioChemistry Procedures Manual" (EPA 1984)

"High-Resolution Gamma-Ray Spectrometry of Water" (ASTM 1985)

^aSee Chapter 3 for discussion on progeny isotopes whose concentrations may be derived from known parent concentrations. Radionuclides related to U-238 include Th-230, Bi-210, Bi-214, Po-214, and Po-218. Radionuclides related to U-235 include Th-231, Tl-207, Pb-211, Pb-214, and Bi-211. Nb-93m is related to Zr-93. Pu-241 concentrations are inferred from Pu-238, Pu-239, and Pu-240. The radionuclides listed in parentheses under the analyte column are measured as part of the analysis of the adjacent radionuclide.

^bThese analytical methods should be considered examples of possible analytical techniques to use. Individual laboratories may have other techniques developed for some analytes. Analytical priorities are discussed in Section 5.1.5.

^cUnits for metals are mg/kg (ppm), µg/L for ions, µg/kg (ppb) for organics, and pCi/g for radionuclides

^dThe uranium analyses will be conducted periodically to confirm the uranium concentrations calculated from the Pa-234m or Pa-231 analyses. Two samples from each boring and one sample from each test pit/auger will undergo this confirmatory analysis. No uranium analyses will be done on surface soil or sediment samples.

^eAnalytes that will be studied by beta counting are listed in the order that they should be analyzed (e.g., the Sr-90 analysis should be made first, followed by the Tc-99 analysis).

Table B-2. Analytes of Interest, Analytical Methods, Quantitation Limits, and Precision and Accuracy Guidelines Modified from DOE-RL 1995 (Table E-1). (Sheet 1 of 5)

Analyte	Analytical Method	Target Quantitation Limit Soil ^{a/}	Precision, Soil ^{b/c/}	Accuracy, Soil ^{b/c/}	Target Quantitation Limit Water ^{a/}	Precision, Water ^{b/}	Accuracy, Water ^{b/}
Acetone	8260	10 µg/kg	±30	70-130	TBD	±20	75-125
Butanol, 1-	8260 ^{d/}	5,000 µg/kg	±30	70-130	TBD	±20	75-125
Butanone, 2- (MEK)	8260	10 µg/kg	±30	70-130	TBD	±20	75-125
Carbon tetrachloride	8260	5 µg/kg	±30	70-130	TBD	±20	75-125
Chloroform	8260	5 µg/kg	±30	70-130	TBD	±20	75-125
Ethyl Ether	8240 ^{d/}	5 µg/kg	±30	70-130	TBD	±20	75-125
Methylene chloride	8260	5 µg/kg	±30	70-130	TBD	±20	75-125
Toluene	8260	5 µg/kg	±30	70-130	TBD	±20	75-125
Trichloroethane, 1,1,1-	8260	5 µg/kg	±30	70-130	TBD	±20	75-125
Trichloroethane, 1,1,2-	8260	5 µg/kg	±30	70-130	TBD	±20	75-125
Formaldehyde	NA ^{d/}	NA					
Kerosene	8270 ^{e/f/}	5,000 µg/kg	±30	±20	TBD	±20	75-125
Tributyl Phosphate	8270 ^{e/f/}	500 µg/kg	±30	70-130	TBD	±20	75-125
Polychlorinated Biphenyls	8080 ^{d/}	21 or 33 µg/kg	±30	70-130	TBD	±20	75-125
Naphthalene	8270 ^{d/}	660 µg/kg	±30	70-130	TBD	±20	75-125
Arsenic	7060 ^{d/} /6010 ^{d/}	0.3 mg/kg	±30	70-130	TBD	±20	75-125
Barium	6010 ^{e/f/}	1 mg/kg	±30	70-130	TBD	±20	75-125
Beryllium	6010 ^{e/f/}	1 mg/kg	±30	70-130	5 mg/l	±20	75-125
Bismuth	6010 ^{e/f/}	10 mg/kg	±30	70-130	TBD	±20	75-125
Boron	6010 ^{e/f/}	10 mg/kg	±30	70-130	TBD	±20	75-125

Table B-2. Analytes of Interest, Analytical Methods, Quantitation Limits, and Precision and Accuracy Guidelines Modified from DOE-RL 1995 (Table E-1). (Sheet 2 of 5)

Analyte	Analytical Method	Target Quantitation Limit Soil ^{a/}	Precision, Soil ^{b/c/}	Accuracy, Soil ^{b/c/}	Target Quantitation Limit Water ^{d/}	Precision, Water ^{b/}	Accuracy, Water ^{b/}
Cadmium	6010 ^{e/f/}	2 mg/kg	±30	70-130	2 mg/L	±20	75-125
Chromium	6010 ^{e/f/}	2 mg/kg	±30	70-130	10 mg/L	±20	75-125
Copper	6010 ^{e/f/}	2 mg/kg	±30	70-130	10 mg/L	±20	75-125
Iron	6010 ^{e/f/}	10 mg/kg	±30	70-130	30 mg/L	±20	75-125
Lead	6010 ^{e/} or 7421 ^{e/}	10 or 0.3 mg/kg (respectively)	±30	70-130	5 mg/L	±20	75-125
Manganese	6010 ^{e/f/}	1 mg/kg	±30	70-130	5 mg/L	±20	75-125
Mercury	7471 ^{e/c/} /245.2 ^{e/w/}	0.1 mg/kg	±30	70-130	0.1 mg/L	±20	75-125
Nickel	6010 ^{e/f/}	4 mg/kg	±30	70-130	10 mg/L	±20	75-125
Potassium	6010 ^{e/f/}	500 mg/kg	±30	70-130	TBD	±20	75-125
Selenium	6010 ^{e/} or 7740 ^{e/}	25 or 0.3 mg/kg (respectively)	±30	70-130	TBD	±20	75-125
Silver	6010 ^{e/f/}	20 mg/kg	±30	70-130	10 mg/L	±20	75-125
Tin	6010 ^{e/} or 7870 ^{e/}	50 mg/kg	±30	70-130	TBD	±20	75-125
Vanadium	6010 ^{e/f/}	2 mg/kg	±30	70-130	TBD	±20	75-125
Zinc	6010 ^{e/}	2 mg/kg	±30	70-130	5 mg/L	±20	75-125
Acetate	8270 ^{e/w/}	50 mg/kg	±30	70-130	TBD µg/L	±20	75-125
Ammonia	350.1 ^{v/}	0.5 mg/kg	±30	70-130	30 µg/L	±20	75-125
Cyanide	9010 ^{e/c/} /320.3 ^{e/w/}	0.5 mg/kg	±30	70-130	3.05 µg/L ^{e/}	±20	75-125
Fluoride (water only) ^{y/}	1C 300 ^{e/} /modified ^{u/}	--	--	--	100 µg/L ^{u/}	±20	75-125

Table B-2. Analytes of Interest, Analytical Methods, Quantitation Limits, and Precision and Accuracy Guidelines Modified from DOE-RL 1995 (Table E-1). (Sheet 3 of 5)

Analyte	Analytical Method	Target Quantitation Limit Soil ^{a/}	Precision, Soil ^{b/k/}	Accuracy, Soil ^{b/k/}	Target Quantitation Limit Water ^{d/}	Precision, Water ^{d/}	Accuracy, Water ^{d/}
Nitrate	IC 300 modified and 353 ^{w/}	1.0 mg/kg	±30	70-130	51 µg/L	±20	75-125
Nitrite	IC 300 modified and 353 ^{w/}	1.0 mg/kg	±30	70-130	100 µg/L	±20	75-125
Sulfate	IC 300	5 mg/kg	±30	70-130	150 µg/L	±20	75-125
Tritium (water only)	Lab SOP ^{w/}	--	--	--	400 pCi/L	±20	75-125
Americium-241	Alpha Lab SOP	1 pCi/g	±30	±30	1 pCi/L	±25	±25
Barium-134m (Cesium-137) ^{w/}	Gamma Lab SOP	0.1 pCi/g	±30	±30	15 pCi/L	±25	±25
Cobalt-60	Gamma Lab SOP	0.05 pCi/g	±30	±30	25 pCi/L	±25	±25
Curium-244	Alpha Lab SOP	1.0 pCi/g	±30	±30	1 pCi/L	±25	±25
Europium-152	Gamma Lab SOP	0.1 pCi/g	±30	±30	50 pCi/L	±25	±25
Europium-154	Gamma Lab SOP	0.1 pCi/g	±30	±30	50 pCi/L	±25	±25
Europium-155	Gamma Lab SOP	0.1 pCi/g	±30	±30	50 pCi/L	±25	±25
Uranium, Total Chemical ^{p/}	Lab SOP	1.0 µg/g	±30	±30	0.1 µg/L	±25	±25
Iodine-129	Beta Lab SOP	2.0 pCi/g	±30	±30	5 pCi/L	±25	±25
Neptunium-237	Alpha Lab SOP	1.0 pCi/g	±30	±30	1 pCi/L	±25	±25
Plutonium-238	Alpha Lab SOP	1.0 pCi/g	±30	±30	TBD	±25	±25
Plutonium-239/240	Alpha Lab SOP	1.0 pCi/g	±30	±30	1 pCi/L	±25	±25
Plutonium-241	Liquid Scintillation Lab SOP	15.0 pCi/g	±30	±30	TBD	±25	±25
Thorium-228	Alpha Lab SOP	1.0 pCi/g	±30	±30	TBD	±25	±25

Table B-2. Analytes of Interest, Analytical Methods, Quantitation Limits, and Precision and Accuracy Guidelines Modified from DOE-RL 1995 (Table E-1). (Sheet 4 of 5)

Analyte	Analytical Method	Target Quantitation Limit Soil ^a	Precision, Soil ^{b/c/d}	Accuracy, Soil ^{b/c/d}	Target Quantitation Limit Water ^d	Precision, Water ^d	Accuracy, Water ^d
Thorium-230	Alpha Lab SOP	1.0 pCi/g	±30	±30	TBD	±25	±25
Thorium-232	Alpha Lab SOP	1.0 pCi/g	±30	±30	TBD	±25	±25
Selenium-79	Beta Counting	10.0 pCi/g ^e	±30	±30	TBD	±25	±25
Uranium-233/234	Alpha Lab SOP	1.0 pCi/g	±30	±30	1 pCi/L	±25	±25
Uranium-235 (Pa-231)	Gamma Lab SOP	0.5 pCi/g	±30	±30	1 pCi/L	±25	±25
Uranium-235/236	Alpha Lab SOP	1.0 pCi/g	±30	±30	TBD	±25	±25
Uranium-238	Alpha Lab SOP	1.0 pCi/g	±30	±30	1 pCi/L	±25	±25
Carbon-14 (water only)	Liquid Scintillation Lab SOP	--	--	--	200.0 pCi/L ^f	±25	±25
Yttrium-90 (Sr-90) ^g	Beta Ctn. Lab SOP	1.0 pCi/g	±30	±30	2 pCi/L	±25	±25
Technetium-99	Beta Ctn. Lab SOP	15.0 pCi/g	±30	±30	15 pCi/L	±25	±25
Gross alpha	Lab SOP	10.0 pCi/g	±30	70-130	3 pCi/L	±20	75-125
Gross beta	Lab SOP	15.0 pCi/g	±30	70-130	4 pCi/L	±20	75-125
Soil Physical and Chemical Properties	--	NA	NA	NA	NA	NA	NA
Bulk Density	ASTM D3550-87	***	***	***	--	--	--
Particle Size Distribution	TBD	***	***	***	--	--	--
Moisture Content	ASTM D2216-90	***	*	***	--	--	--
CaCO ₃ Content	ASTM D4373	***	***	***	--	--	--
Saturated Hydraulic Conductivity	ASTM D5084	***	***	***	--	--	--
Unsaturated Hydraulic Conductivity	****	***	***	***	--	--	--

Table B-2. Analytes of Interest, Analytical Methods, Quantitation Limits, and Precision and Accuracy Guidelines Modified from DOE-RL 1995 (Table E-1). (Sheet 5 of 5)

Analyte	Analytical Method	Target Quantitation Limit Soil ^d	Precision, Soil ^{h/k}	Accuracy, Soil ^{h/k}	Target Quantitation Limit Water ^a	Precision, Water ^h	Accuracy, Water ^h
Matric Potential and Soil Moisture Retention Curves	ASTM D2325-68, D3152-72	***	***	***	--	--	--
Particle Density	ASTM D854	***	**	***	--	--	--
Cation Exchange Capacity	SW 846 9081/9080	--	--	--	--	--	--
Organic Carbon Content	SW 846 9060	--	--	--	--	--	--
pH and if possible Eh	ASTM G51, 9040/9045 ^k	--	--	--	--	--	--

- ^a Values are to be considered requirements in the absence of known or suspected analytical interferences which may hinder achieving the limit by the analytical laboratory.
- ^b Precision is expressed as relative percent difference; accuracy is expressed as percent recovery. These limits apply to sample results greater than five times the target quantitation limit and are to be considered requirements in the absence of known or suspected analytical interferences which may hinder achieving the limit by the analytical laboratory.
- ^c Methods specified from *Test Methods for Evaluating Solid Waste: Chemical/Physical Methods* (EPA 1990).
- ^d Water analysis.
- ^e Soil analysis.
- ^f Method is from *Determination of Inorganic Anions in Aqueous and Solid Samples by Ion Chromatography* (Lindahl 1984) and is modified from EPA method 300.0.
- ^g 1-butanol and ethyl ether will analyzed as a Tentatively Identified Compounds (TICs) under 8240. Formaldehyde, kerosene, and acetate will be analyzed as TICs under 8270. Tributyl Phosphate will be analyzed using a special calibration under 8270. Additionally, all RCRA treatment, storage, and disposal waste management unit (excluding the Expansion Ponds) samples will include analytes for the volatile (8240) and semi-volatile (8270) Tentative Identified Compounds (TICs).
- ^h The first radionuclide is analyzed in order to derive a concentration for the radionuclide in parentheses.
- ⁱ Modification to Table E-1 (DOE-RL 1995) to be consistent with Table 5-7 or Table 3-2 (DOE-RL 1995); Uranium will be analyzed as total chemical uranium. If total uranium exceeds 10 µg/mg individual isotopes will be analyzed using lab SOPs with a detection limit of 1.0 pCi/g including U-233/234, U-235, U-236, and U-238.
- ^j ICP 6010 (supertrace) can be performed; yields Selenium at 0.5 mg/kg, and lead at 0.5 mg/kg; modification to Table 5-7 (DOE-RL 1995).
- ^k Modification to Table E-1 (DOE-RL 1995).
- ^l Analyzed as a tentatively identified compound (TIC).
- ^m Cannot analyze as a TIC under 8270.
- * Single Operator precision for 2 properly conducted tests should not be considered suspect unless they vary by more than 7.8% of their mean.
- ** Precision estimates for cohesive soils vary with grain size. No precision estimates cited for non-cohesive soils.
- *** ASTM practice does not produce numerical or repeatable data. Therefore, a precision and bias statement is not applicable. ASTM practice does not provide precision and bias statements due to inherent variability of soil.
- ****No established ASTM tests, tests currently not available
- SOP Standard Operating Procedure

Table B-3. Required Preservation, Container Type, Container Volume, and Holding Times. (Sheet 1 of 2)

Analyte	Method	WATER				SOIL					
		Volumes		Preservation	Container	Hold Time	Volumes		Preservation	Container	Hold Time
		Minimum	Full QC				Minimum	Full QC			
VOA	8240	1 x 40ml	3 x 40ml	Cool 4C, HCl or H2SO4 to pH <2	Gs*	14 days	1 x 5g	1 x 20g	Cool 4C	G	14 days
SemiVOA	8270	1 x 1000ml	2 x 1000ml	Cool 4C	aG	7/40 ¹	1 x 30g	1 x 120g	Cool 4C	aG	14/40 ¹
PCB's	8080	1 x 1000ml	2 x 1000ml	Cool 4C	aG	7/40 ¹	1 x 30g	1 x 120g	Cool 4C	aG	14/40 ¹
ICP (Supertrace)	6010	1 x 300ml	1 x 500ml	HNO3 to pH <2	G/P	6 mos	1 x 4g	1 x 15g	none	G/P	6 mos
Arsenic	7060	1 x 300ml	1 x 500ml	HNO3 to pH <2	G/P	6 months	1 x 4g	1 x 15g	HNO3 to pH <2	G/P	6 months
Lead	7421	1 x 300ml	1 x 500ml	HNO3 to pH <2	G/P	6 months	1 x 4g	1 x 15g	HNO3 to pH <2	G/P	6 months
Selenium	7740	1 x 300ml	1 x 500ml	HNO3 to pH <2	G/P	6 months	1 x 4g	1 x 15g	HNO3 to pH <2	G/P	6 months
Ammonia	350.1	1 x 50ml	1 x 300ml	Cool 4C, H2SO4 to pH <2	G/P	28 days	1 x 10g	1 x 40g	Cool 4C	G/P	28 days
Cyanide	9010	1 x 500ml	2 x 1000ml	Cool 4C, NaOH to pH >=2	G/P	14 days	1 x 10g	1 x 40g	Cool 4C	G	14 days
Anions	353.1/300.0	1 x 100ml	1 x 300ml	Cool 4C	G/P	28days/48hrs*	1 x 10g	1 x 40g	none	G/P	20days/48hrs
Gross alpha/beta	GA/GB	1 x 200ml	1 x 600ml	HNO3 to pH <2	G/P	6 months	1 x 1g	1 x 2g	none	G/P	6 months
Tritium (water only)	H3	1 x 500ml	1 x 1500ml	none	G	6 months					
Am-241/Cm-244	AM241/CM244	1 x 200ml	1 x 600ml	HNO3 to pH <2	G/P	6 months	1 x 2g	1 x 6g	none	G/P	6 months
Gamma scan	GAMMA	1 x 100ml	1 x 2250ml	HNO3 to pH <2	G/P	6 months	1 x 500g	1 x 1500g	none	G/P	6 months
P-129	I129	1 x 1500ml	1 x 4500ml	none	G/P	6 months	1 x 500g	1 x 1500g	none	G/P	6 months
Np-237	NP237	1 x 200ml	1 x 600ml	HNO3 to pH <2	G/P	6 months	1 x 2g	1 x 6g	none	G/P	6 months
Isotopic Pu	PUAEA	1 x 200ml	1 x 600ml	HNO3 to pH <2	G/P	6 months	1 x 2g	1 x 6g	none	G/P	6 months
Pu-241	PU241	1 x 1000ml	3 x 1000ml	HNO3 to pH <2	G/P	6 months	1 x 2g	1 x 6g	none	G/P	6 months
Isotopic Th	THAEA	1 x 200ml	1 x 600ml	HNO3 to pH <2	G/P	6 months	1 x 2g	1 x 6g	none	G/P	6 months
Sm-151	not available	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Se-79	SE79	1 x 500ml	1 x 1500ml	HNO3 to pH <2	G/P	6 months	1 x 2g	1 x 6g	none	G/P	6 months
Total U	TOTALU	1 x 100ml	1 x 300ml	HNO3 to pH <2	G/P	6 months	1 x 2g	1 x 3g	none	G/P	6 months
Isotopic U	UAEA	1 x 200ml	1 x 600ml	HNO3 to pH <2	G/P	6 months	1 x 2g	1 x 6g	none	G/P	6 months
C-14 (water only)	C14	1 x 500ml	1 x 1500ml	none	G/P	6 months					
Total Sr	SR8990/TOTAL	1 x 1000ml	3 x 1000ml	HNO3 to pH <2	G/P	6 months	1 x 6g	1 x 6g	none	G/P	6 months
Tc-99	TC99	1 x 1000ml	3 x 1000ml	HNO3 to pH <2	G/P	5 months	1 x 2g	1 x 6g	none	G/P	6 months
Bulk density ²	ASTM D3550-87	n/a	n/a	n/a	n/a	n/a	TBD		C ³	C ³	ASAP ⁴
Particle size distribution ²	ASTM D422	n/a	n/a	n/a	n/a	n/a	20-100 ³		B ³	B ³	N/A
Moisture content	ASTM D2216-92	n/a	n/a	n/a	n/a	n/a	20-5000 ³		C ³	C ³	ASAP
CaCO3 content	ASTM D4373-84	n/a	n/a	n/a	n/a	n/a	1-2 gm		A ³	A ³	N/A
Saturated hydraulic conductivity ²	ASTM D5084	n/a	n/a	n/a	n/a	n/a	25 g ³		C ³	C ³	ASAP
Moisture retention	ASTM D2325-68	n/a	n/a	n/a	n/a	n/a	10 x 25 g/min		B ³ , C ³	B ³ , C ³	ASAP
Particle density ²	ASTM D854	n/a	n/a	n/a	n/a	n/a	TBD ³		B ³	B ³	N/A
Cation exchange capacity	9081	n/a	n/a	n/a	n/a	n/a	TBD		TBD	TBD	TBD
Organic carbon content (TOC)	9060	TBD	1 x 250ml	Cool 4C, HCl or H2SO4 to pH <2	aG	28 days	TBD		none	aG	28 days
pH	9040	1 x 50ml	1 x 100ml	none	G/P	asap					

Table B-2. Required Preservation, Container Type, Container Volume, and Holding Times. (Sheet 2 of 2)

Analyte	Method	WATER					SOIL				
		Volumes		Preservation	Container	Hold Time	Volumes		Preservation	Container	Hold Time
		Minimum	Full QC				Minimum	Full QC			
pH	9045	-	-	-	-	-	1 x 5g	1 x 10g	none	G/P	asap
Specific conductance	9050	1 X 100ml	1 x 200ml	Cool 4C	P	28 days	1 X 100g	1 x 200g	Cool 4C	G/P	28 days
FeH	not available	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Bulk density	ASTM D2937	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	none

Container Types

G = Glass

Gs* = Glass w/ septum cap -- no head space in container

P = Plastic

aG = Amber Glass

1 First number is for extraction. Second number is for analysis.

2 Test is not currently available

3 Per ASTM standard D-4220

Type A-unsealed bags/jars

Type B-moisture proof bags, jars, or tubes

Type C-Same as type B, but with protected transportation packaging

4 ASAP - Samples are sealed to be moisture proof and stored properly, but should be tested as soon as possible, for best results

5 Volume of sample required determined by ASTM maximum particle size in sample, ASTM standards stated

6 Bulk density sample volume not stated, ASTM recommends avoiding material with size fraction greater than 4.75 mm with 3.5 inch to 5.0 inch OD sampler

7 Due to variability of soil properties, per ASTM, precision and bias statements are generally not applicable

8 48 hours holding times will not be met. A 48 hour holding time is not considered to be cost effective

Table B-4. Sample Type Designation Codes.

Sample Type	Sample Type Designation	Purpose of Sample
Chemical	CH	Provide material for chemical and radiological analysis to determine contaminant inventory and extent of contamination in cribs and vadose zone.
Physical	PH	Provide material for determination of physical characteristics of soil and sediment.
Archive	AR	Provide materials for future chemical analysis or physical properties testing. Provides a representative physical record of the lithologies encountered during drilling activities.

Table B-5. Quality Assurance Control Samples.

Parameters	Field ^{a/} Samples	Field Duplicate Sample	Field and Equipment Rinsate Blanks	VOA Trip Blank
Soil Physical Properties - Type A ^{b/}	11	1	NA	NA
Soil Physical Properties - Type B ^{c/}	2	1	NA	NA
Soil Chemistry/Rad	13	1	1	TBD
Perched Water Chemistry/Rad	1	1	1	1

^{a/} Approximate number of field samples.

^{b/} Type A samples will be run for the following analyses: moisture content, bulk density, particle-size distribution, CaCO₃, and pH.

^{c/} Type B samples will be run for Type A analyses: saturated hydraulic conductivity, cation exchange capacity, moisture retention curves, organic carbon content, unsaturated hydraulic conductivity, and if possible, Eh and mineralogy.

APPENDIX C
QUALITY ASSURANCE PROJECT PLAN

ACRONYMS

ASTM	American Society for Testing and Materials
BHI	Bechtel Hanford, Inc.
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act</i>
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DQO	data quality objective
EIP	Environmental Investigations Procedure
EPA	U.S. Environmental Protection Agency
GC	gas chromatography
HASQARD	Hanford Analytical Services Quality Assurance Requirements Document
HEIS	Hanford Environmental Information System
IMO	Information Management Overview
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QPP	Quality Program Procedure
RCRA	<i>Resource Conservation and Recovery Act</i>
SAF	sample authorization form
SDG	Sample Disposition Record
VOA	volatile organics analysis
WHC	Westinghouse Hanford Company

GLOSSARY

Accuracy: Accuracy may be interpreted as the measure of the bias in a system. The factors that influence the accuracy of the data include sample procedures, field conditions, sample preservation, sample matrix, instrument calibration, and analysis technique. Sampling accuracy is normally assessed through the evaluation of matrix-spiked samples and reference samples (see glossary entry).

Audit: For the purposes of environmental investigations, audits are considered to be systematic checks to verify the quality of operation of one or more elements of the total measurement system. In this sense, audits may be of two types: (1) performance audits, in which quantitative data are independently obtained for comparison with data routinely obtained in a measurement system, or (2) system audits, involving a qualitative onsite evaluation of laboratories or other organizational elements of the measurement system for compliance with established quality assurance program and procedure requirements. For environmental investigations at the Hanford Site, performance audit requirements are fulfilled by periodic submittal of blind samples to the primary laboratory, or the analysis of split samples by an independent laboratory. System audit requirements are implemented through the use of standard surveillance procedures.

Bias: Bias represents a systematic error that contributes to the difference between a population mean of a set of measurements and an accepted reference or true value.

Blind Sample: A blind sample refers to any type of sample routed to the primary laboratory for performance audit purposes, relative to a particular sample matrix and analytical method. Blind samples are not specifically identified as such to the laboratory. They may be made from traceable standards, or may consist of sample material spiked with a known concentration of a known compound. See the glossary entry for Audit.

Comparability: For the purposes of environmental investigations, comparability is an expression of the relative confidence with which one data set may be compared with another.

Completeness: For the purposes of environmental investigations, completeness may be interpreted as a measure of the amount of valid data obtained compared to the total data expected under correct normal conditions.

Deviation: For the purposes of environmental investigations, deviation refers to an approved departure from established criteria that may be required as a result of unforeseen field situations or that may be required to correct ambiguities in procedures that may arise in practical applications.

Equipment Blanks: Equipment blanks consist of pure deionized distilled water washed through decontaminated sampling equipment and placed in containers identical to those used for actual field samples. They are used to verify the adequacy of sampling equipment decontamination procedures, and are normally collected at the same frequency as field duplicate samples.

Field Blanks: Field blanks for water analyses consist of pure deionized distilled water transferred to a sample container at the site and preserved with the reagent specified for the analyses of interest. They are used to check for possible contamination originating with the reagent or the sampling environment, and are normally collected at the same frequency as field duplicate samples.

Field Duplicate Sample: Field duplicate samples are samples retrieved from the same sampling location using the same equipment and sampling technique, placed in separate, identically prepared and preserved containers, and analyzed independently.

Matrix-Spiked Samples: Matrix-spiked samples are a type of laboratory quality control sample. They are prepared by splitting a sample received from the field into two homogenous aliquots (i.e., replicate samples) and adding a known quantity of a representative analyte of interest to one aliquot in order to calculate the percentage of recovery of that analyte and as a test of laboratory accuracy.

Nonconformance: A nonconformance is a deficiency in the characteristic, documentation, or procedure that renders the quality of material, equipment, services, or activities unacceptable or indeterminate. When the deficiency is of a minor nature, does not effect a permanent or significant change in quality if it is not corrected, and can be brought into conformance with immediate corrective action, it shall not be categorized as a nonconformance. If the nature of the condition is such that it cannot be immediately and satisfactorily corrected, however, it shall be documented in compliance with approved procedures and brought to the attention of management for disposition and appropriate corrective action.

Precision: Precision is a measure of the repeatability or reproducibility of specific measurements under a given set of conditions. The relative percent difference is used to assess the precision of the sampling and analytical method. The relative percent difference is a quantitative measure of the variability. Specifically, precision is a quantitative measure of the variability of a group of measurements compared to their average value. Precision is normally expressed in terms of standard deviation, but may also be expressed as the coefficient of variation (i.e., relative standard deviation) and range (i.e., maximum value minus minimum value). Precision is assessed by means of duplicate/replicate sample analysis.

Quality Assurance: For the purposes of environmental investigations, quality assurance refers to the total integrated quality planning, quality control, quality assessment, and corrective action activities that collectively ensure that the data from monitoring and analysis meet all end-user requirements and/or the intended end use of the data.

Quality Assurance Project Plan: The QAPjP is an orderly assembly of management policies, project objectives, methods, and procedures that defines how data of known quality will be produced for a particular project or investigation.

Quality Control: For the purposes of environmental investigations, quality control refers to the routine application of procedures and defined methods to the performance of sampling, measurement, and analytical processes.

Range: Range refers to the difference between the largest and smallest reported values in a sample, and is a statistic for describing the spread in a set of data.

Reference Samples: Reference samples are a type of laboratory quality control sample prepared from an independent, traceable standard at a concentration other than that used for analytical equipment calibration, but within the calibration range.

Replicate Sample: Replicate samples are two aliquots removed from the same sample container in the laboratory and analyzed independently.

Representativeness: For the purposes of environmental investigations, representativeness may be interpreted as the degree to which data accurately and precisely represent a characteristic of a population parameter, variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that is most concerned with the proper design of a sampling program.

Split Sample: A split sample is produced through homogenizing a field sample and separating the sample material into two equal aliquots. Field split samples are usually routed to separate laboratories for independent analysis, generally for purposes of auditing the performance of the primary laboratory relative to a particular sample matrix and analytical method. See the glossary entry for Audit. In the laboratory, samples are generally split to create matrix-spiked samples (see the glossary entry).

VOA Trip Blanks: Volatile organics analysis (VOA) trip blanks are a type of field quality control sample, consisting of pure deionized distilled water in a clean, sealed sample container, accompanying each batch of containers shipped to the sampling site and returned unopened to the laboratory. Trip blanks are used to identify any possible contamination originating from container preparation methods, shipment, handling, storage or site conditions.

Validation: For the purposes of environmental investigations, validation refers to a systematic process of reviewing data against a set of criteria to provide assurance that the data are acceptable for their intended use. Validation methods may include review of verification activities, editing, screening, cross-checking, or technical review.

Verification: For the purposes of environmental investigations, verification refers to the process of determining whether procedures, processes, data, or documentation conform to specified requirements. Verification activities may include inspections, audits, surveillance, or technical review.

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1.0 PROJECT DESCRIPTION

1.1 PROJECT OBJECTIVE

The draft *200-BP-11 Operable Unit RFI/CMS and 216-B-3 Main Pond, 216-B-63 Trench, and 216-A-29 Ditch Work/Closure Plan* (DOE/RL-93-74) and its supporting project plans have been developed to meet specific U.S. Environmental Protection Agency (EPA) guidelines for format and structure, within the overall quality assurance (QA) program structure mandated by the U.S. Department of Energy, Richland Operations Office (DOE-RL) for all activities at the Hanford Site. These DOE mandates include DOE Order 5700.6C, *Quality Assurance* (DOE 1991), DOE/RL-90-28, *Environmental Restoration Program Quality Assurance Systems Requirements for the Hanford Site* (DOE-RL 1993), and other QA guidance documents as applicable, e.g., the *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD) (DOE-RL 1997). The purpose of this Quality Assurance Project Plan (QAPjP) is to ensure the objectives described above and in Section 1.5 of this work/closure plan will be met. Data resulting from this investigation will be evaluated to determine the most feasible options for additional investigation, remediation, or closure.

1.2 BACKGROUND INFORMATION

The 200-BP-11 Source Operable Unit is located within the 200 Areas of the Hanford Site, shown in Figure 1-1 of the work/closure plan. The waste management units that will be studied during the 200-BP-11 Source Operable Unit field investigation are discussed in Chapter 1.

Detailed background information regarding the history and current use of the operable unit is provided in Chapter 2 of the work/closure plan.

1.3 QUALITY ASSURANCE PROJECT PLAN APPLICABILITY AND RELATIONSHIP TO THE BECHTEL HANFORD, INC. QUALITY ASSURANCE PROGRAM

This QAPjP applies specifically to the field activities and chemical laboratory analyses performed as part of the field investigation for the 200-BP-11 Source Operable Unit. This plan describes the means selected to implement the overall QA program requirements defined by the *ERC Quality Program* (BHI 1997), as applicable to the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) and *Resource Conservation and Recovery Act* (RCRA) facility investigation/corrective measures study environmental investigations. The QAPjP is subject to mandatory review and revision prior to use on any subsequent phases of the investigation. Distribution and revision control procedures applicable to the QAPjP and work/closure plan shall be in compliance with Part 1, Section 4 of the *ERC Quality Program* (BHI 1997). Interim changes to this QAPjP or the work/closure plan shall be documented, reviewed, and approved as required by Environmental Investigations Procedure (EIP) 1.3, "Work

Plan Review and Control" (BHI 1996), and shall be documented in monthly unit managers' meeting minutes. The QAPjP distribution shall routinely include all review/approval personnel indicated on the title page of the document and all other individuals designated by the BHI technical lead for each investigation. All plans and procedures referenced in the QAPjP are available for regulatory review on request by the direction of the technical lead.

1.4 SCHEDULE OF ACTIVITIES

Five separate investigations will be conducted in the 200-BP-11 Source Operable Unit, including geological, surface water and sediment, groundwater, and ecological investigations, as well as an investigation made up of other miscellaneous tasks. More detailed discussions of individual tasks are contained in Chapter 5 of the work/closure plan. Procedures directly applicable to the tasks described here are discussed in Chapter 4 of the QAPjP.

The field-related tasks to be conducted are:

- Task 2: Source Characterization
- Task 3: Geologic Investigation
- Task 4: Surface Water/Sediment Investigation
- Task 5: Vadose Zone Investigation
- Task 6: Air Investigation.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 TECHNICAL LEAD RESPONSIBILITIES

The Remedial Action/Waste Management Project (RA/WM) of BHI has primary responsibilities for conducting this investigation.

External participant contractors or subcontractors shall be evaluated and selected for certain portions of task activities at the direction of the technical lead in compliance with Section 4 of the *ERC Quality Program* (BHI 1997). Major participant contractor and subcontractor resources are discussed in Chapter 7 of the work/closure plan. All contractor QA plans and field and laboratory procedures shall be approved by BHI prior to use and shall be made available for regulatory review at the direction of the BHI technical lead.

2.2 ANALYTICAL LABORATORIES

Regardless of the radiation levels observed during field screening, all samples shall be screened for total activity counts and isotopic identification prior to shipment to the analytical laboratory.

Those samples with short holding times, such as volatile organic analyses (VOAs), will be given the highest priority during this screening to ensure that holding times are not exceeded.

Packaging and shipping requirements shall be selected on the basis of total activity values and the preservation requirements applicable to the parameters of interest, as described in EIP 3.1, "Sample Packaging and Shipping" (BHI 1996). All analyses shall be coordinated through BHI Sample Management and shall be performed in compliance with BHI-approved laboratory QA plans and analytical procedures; all analytical laboratories shall be subject to the inspection controls described by Part 2, Section 8.2 of the *ERC Quality Program* (BHI 1997) and Quality Program Procedures (QPP) 3.1, "Surveillance" (BHI 1995). For subcontractors or participant contractors, applicable quality requirements shall be invoked as part of the approved procurement documentation or work order; see Section 4.2. Services of alternate qualified laboratories shall be procured for radioactive sample analysis if onsite laboratory capacity is not available, and/or for the performance of split sample analysis at the technical lead's discretion. If such an option is selected, the laboratory QA plan and applicable analytical procedures from the alternate laboratory shall be approved by BHI before their use, as noted in Section 4.2.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENTS

The rationale for establishing data quality objectives (DQOs) and data needs for this investigation are presented in Section 4.1 of the work/closure plan. Analytical procedures are discussed in Chapter 7 of the QAPjP and include both standard and nonstandard procedures. Standard EPA methods selected from *Test Methods for Evaluating Solid Waste* (EPA 1986) shall be used for analysis of metals and organics as shown in Table B-2 in the SAP (Appendix B). Laboratory-specific methods based on industry standard methodologies, reviewed and accepted by BHI personnel, will be utilized for the analysis of radiological parameters. However, these laboratory-specific methodologies will coincide with the analytical technology (e.g., gamma spectrometry) specified in DQOs. Analysis of the soil physical properties will require both standard American Society for Testing and Materials (ASTM) methods and nonstandard methods as described in Chapters 4 and 5 of the work/closure plan. Methods for soil analysis have been published by the American Society of Agronomy, and include *Methods of Soil Analysis, Part 1* (Klute 1986) and *Methods of Soil Analysis: Part 2 - Chemical and Microbiological Properties* (Page et al. 1982). These reference methods will form the basis of project-specific test procedures that shall be developed, reviewed, approved, and issued in compliance with Section 15 of the *ERC Quality Program* (BHI 1997).

All of the analytical parameters selected for the soil and water sampling phase of this investigation are listed in Table B-2 of the SAP and cross-referenced to analytical method requirements and maximum quantitation limit or detection limit values and maximum acceptable ranges for precision and accuracy in soil matrices. Where Practical Quantitation Limits are not defined for a particular parameter listed in Table B-2, Contractually Required Quantitation Limits are provided that represent maximum values that can be reliably achieved by analytical

laboratories under normal conditions. Precision and accuracy values are provided for all chemical and radiological parameters that also represent maximum values that can be reliably achieved by analytical laboratories under normal conditions. The requirements of Table B-2 shall be considered a minimum performance standard and shall be incorporated into the agreements for services established with individual BHI, participant contractor, or subcontractor analytical laboratories.

Goals for data representativeness are addressed qualitatively by the specification of sampling depths and intervals in Section 4.2 of the work/closure plan. Sampling locations are specified in the DOW. Objectives for the completeness of this investigation shall require that contractually or procedurally established requirements for precision and accuracy be met for at least 90% of the total number of requested determinations. Failure to meet this criterion shall be documented and evaluated in the validation process described in Chapter 8 of the 200-BP-11 Work/Closure Plan; corrective action shall be taken as warranted, as described in Chapter 13. Approved analytical procedures shall require the use of the reporting techniques and units specified in the EPA reference methods in Table B-2 of the SAP to facilitate the comparability of data sets in terms of precision and accuracy.

4.0 SAMPLING PROCEDURES

4.1 PROCEDURES

The procedures that will be used to support the work/closure plan shall be primarily selected from BHI's system. Selected procedures will include EIPs from the *Environmental Investigations Procedures* (BHI 1996), and procedures from the *ERC Quality Program* (BHI 1997). Procedure approval, revision, and distribution control requirements applicable to EIPs are addressed in EIP 1.1, "Preparing, Revising, and Canceling Environmental Investigations Procedures" (BHI 1996). Other procedures applicable to the preparation, review, and revision of analytical services and other Hanford analytical laboratory procedures shall comply with the requirements of Section 5 of the *ERC Quality Program* (BHI 1997). All procedures are available for regulatory review on request at the direction of the technical lead.

4.2 PARTICIPANT CONTRACTOR/SUBCONTRACTOR PROCEDURES

As previously noted in Section 2.1, participant contractor and/or subcontractor services shall be procured under the applicable requirements of the *ERC Quality Program* (BHI 1997). Submittal of procedures for BHI review and acceptance before use shall be included in the procurement document or work order, as applicable, when such services require procedural controls. Analytical laboratories shall be required to submit the current version of their internal QA program plans, and analytical procedures for review and acceptance by qualified personnel from

the BHI Sample Management group, or other qualified personnel, as directed by the technical lead.

All reviewers shall be qualified under the requirements of EIP 1.12, "Indoctrination, Training, and Qualification" (BHI 1996), or Section 2 of the *ERC Quality Program* (BHI 1997), as applicable. All participant contractor or subcontractor procedures, plans, and/or manuals shall be retained as project records in compliance with Section 4 of the *ERC Quality Program* (BHI 1997).

4.3 PROCEDURE CHANGES

Should deviations from established EIPs be required to accommodate unforeseen field situations, they may be authorized by the field team leader in accordance with the requirements specified in EIP 1.1, "Preparing, Revising, and Cancelling Environmental Investigations Procedures" (BHI 1996). Documentation, review, and disposition of instruction change authorization forms shall be as defined by EIP 1.1. Other types of procedure change requests shall be documented as required by Part 1, Section 5 of the *ERC Quality Program* (BHI 1997). To deviate from established radiation monitoring procedures, a field change request shall be completed in accordance with the *Hanford Site Radiological Control Manual* (BHI 1994a) and approved by the Occupational Health and Safety manager assigned to this investigation.

4.4 SAMPLING PROCEDURES

4.4.1 Sample Acquisition

All soil and sediment sampling shall be performed in accordance with EIP 4.0, "Soil and Sediment Sampling" (BHI 1996). Perched water sampling shall be performed in compliance with EIP 4.1, "Groundwater Sampling" (BHI 1996); soil-gas sampling shall be performed in compliance with EIP 5.1, "Soil-Gas Sampling" (BHI 1996). Surface water and other specialized types of sampling shall be in compliance with EIPs developed in accordance with EIP 1.1, "Preparing, Revising, and Cancelling Environmental Investigations Procedures" (BHI 1996), or BHI-approved participant contractor or subcontractor procedures. All drilling activities shall be in compliance with BHI-SPEC-00008, *Technical Specification for Environmental Drilling Services* (BHI 1994b). All boreholes shall be logged in compliance with EIP 7.0, "Geologic Logging" (BHI 1996). Sampling procedure applicability to individual project tasks is shown in Table 5-2 of the work/closure plan. Sampling depths and intervals will be identified in site-specific descriptions of work prepared in compliance with EIP 1.4, "Preparing and Revising Descriptions of Work" (BHI 1996). Sample locations will be detailed in the statements of work or work orders issued to the responsible subcontractors or participating contractors. Documentation requirements are contained within individual EIPs and the Information Management Overview (IMO).

Sample container types, preservation requirements, analyses, and special handling requirements are defined in EIP 4.0, "Soil and Sediment Sampling" (BHI 1996). Sample authorization forms (SAFs) will be produced by Sample Management to further define these requirements. Written instructions on these requirements shall be provided by a description of work prior to conducting sampling activities.

4.4.2 Radiological Testing

The BHI field sampling team leader and the assigned Radiation Control Technician (RCT) shall be responsible for screening all samples collected to determine proper handling protocols, in compliance with the Radiation Work Permit established for the sampling site. At a minimum, all sampler assemblies shall be screened for alpha and beta gamma radiation with field instrumentation in compliance with descriptions of work written for specific activities. Sampler assemblies that do not exhibit radiation above background levels may be opened and sample materials extracted and placed in appropriate containers in compliance with EIP 4.0, "Soil and Sediment Sampling" (BHI 1996). Any samples exhibiting radiation levels during field screening that are above background will be handled per approved Radiation Work Permits.

4.4.3 Geologic and Geophysical Testing

Borehole logging shall be conducted concurrent with the drilling operations. A well sheet summary shall be completed for the entire length of the boring activity for each day. The summary sheet shall contain the geologic and construction information listed in EIP 7.0, "Geologic Logging" (BHI 1996).

4.5 OTHER INVESTIGATIVE AND SUPPORTING PROCEDURES

Procedures that will be required in this investigation are identified in the text of the work/closure plan and in Table E-2. Documentation requirements shall be addressed within individual procedures and/or the IMO as appropriate. Analytical procedures required for this investigation are listed in Table E-1. All computer software models developed for this investigation shall be documented and verified to comply with procedures identified under Part 2, Section 6.3 of the *ERC Quality Program* (BHI 1997).

4.6 RECORDS

Records requirements for sample collection include (but are not limited to) field notebooks, chain-of-custody records, sample analysis request forms, geologic logs, scintillation logs, and other documents. All records shall be managed in compliance with Part 2, Section 4 of the *ERC Quality Program* (BHI 1997), and the Section 3.0, *ERC Administrative Guidelines* (BHI 1995).

5.0 SAMPLE CUSTODY

5.1 CHAIN-OF-CUSTODY PROCEDURES

All samples obtained during the course of this investigation shall be controlled as required by EIP 3.0, "Chain of Custody" (BHI 1996), from the point of origin to the analytical laboratory. Samples are to be prepared, packaged, and transported to the laboratory in accordance with EIP 3.1, "Sample Packaging and Shipping" (BHI 1996). Laboratory chain-of-custody procedures shall be reviewed and approved in compliance with the requirements of Section 4.1 of this QAPjP, and shall ensure the maintenance of sample integrity and identification throughout the analytical process. At the direction of the technical lead, requirements for the return of residual sample materials after completion of analysis shall be defined in accordance with procedures described in the procurement documentation to subcontractor or participant contractor laboratories. Chain-of-custody forms shall be initiated for returned residual samples as required by the approved procedures applicable within the laboratory. All analytical results shall be controlled as permanent project quality records as required by EIPs 2.0 through 2.7 (BHI 1996). Section 4 of the *ERC Quality Program* (BHI 1997).

6.0 CALIBRATION PROCEDURES

The procedural control for the use, handling, maintenance, and calibration of health and safety monitoring instruments used in RCRA and CERCLA investigations shall be done in accordance with the *ERC Quality Program* (BHI 1997). Calibration of all BHI measuring and test equipment, whether in existing inventory or procured for this investigation, shall be controlled as required by Section 13 of the *ERC Quality Program* (BHI 1997). The instruments used for geophysical borehole logging shall be calibrated and operated in accordance with *Base Calibration of Pacific Northwest Laboratory's Gross Gamma Borehole Geophysical Logging System* (WHC 1992). All calibration of analytical laboratory equipment shall be as defined by applicable standard analytical methods and are subject to BHI review and acceptance prior to use.

7.0 ANALYTICAL PROCEDURES

Analytical methods or procedures for each parameter identified in Table B-2 of the SAP (Appendix B) shall be selected or developed and approved before use to comply with appropriate WHC and/or BHI procedures and/or procurement control requirements. Table B-2 contains minimum requirements that shall be considered minimum performance standards that shall be incorporated into the agreements for services established with all analytical laboratories.

The final requirements for sample preservation, containers, and holding times for each of the analytes of interest will be specified in the SAF from Sample Management. The preservation technique should be initiated immediately after the sample is extracted. Holding time is based on the maximum amount of time allowable, if proper preservation techniques are applied, to analyze the sample before the validity of the data could be considered suspect. All analytical procedures approved for use in this investigation shall require the use of standard units to facilitate the comparability of data sets in terms of precision and accuracy. All approved procedures shall be retained in the project quality records and shall be available for review on request.

Table B-2 lists various methods for the analysis of parameters listed. Standard EPA approved methods for evaluating solid waste (i.e., *Test Methods for Evaluating Solid Wastes* [EPA 1990]) will be used for analysis of the metals and organics. Geochemical and physical property testing will be conducted based on ASTM or other nationally recognized consensus methods. All test methods shall be documented by the laboratory and submitted for BHI review and acceptance prior to use. These tests shall be performed in accordance with Section 15 of the *ERC Quality Program* (BHI 1997).

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

8.1 DATA REDUCTION AND DATA PACKAGE PREPARATION

All analytical laboratories shall be responsible for preparing a report summarizing the results of analysis and for preparing a detailed data package. The data package includes identifying samples, sampling and analysis dates, raw analytical data, reduced data, data outliers, reduction formulas, recovery percentages, quality control check data, equipment calibration data, supporting chromatogram or spectrograms, and documentation of any nonconformances affecting the measurement system in use during the analysis of the particular group of samples. Data reduction schemes shall be contained within individual laboratory analytical methods and/or QA manuals, submitted for BHI review and acceptance as discussed in Section 4.1. The completed data package shall be reviewed and approved by the analytical laboratory's QA manager (or field team leader for field screening type analysis) before its submittal to the BHI technical lead. Completed data packages shall be submitted to Sample and Data Management for tracking and data validation functions. All data packages shall be verified; the percentage of data packages requiring full validation will be established based on the end use of the data. The requirements of this section shall be included in procurement documentation or work orders, as appropriate, to comply with the standard BHI procurement control procedures noted in Section 4.1.

8.2 VALIDATION

Validation of the completed data package will be performed by qualified BHI Sample Management personnel or by a qualified independent contractor. Subcontracted validation responsibilities shall be defined in procurement documentation or work orders as appropriate. All validation shall be performed in compliance with EIP (BHI 1996). Data validation has been previously agreed to by the ERC, DOE-RL, Washington Department of Ecology, and EPA as follows: Initially, summary deliverables will be requested for all data packages. After evaluation of the analytical results, the data packages for validation will be prioritized based on the samples with the highest contaminant concentrations. The data packages selected for validation will then be upgraded with standalone deliverables. Regardless of the analytical results, at least 20% of the data packages will be validated. The overall progress of data package validation will be communicated to DOE, Ecology and EPA for their concurrence.

8.3 FINAL REVIEW AND RECORDS MANAGEMENT CONSIDERATIONS

All validation reports and supporting analytical data packages shall be subject to a final technical review by a qualified reviewer at the direction of the BHI technical lead, before their submittal to regulatory agencies or inclusion in reports or technical memoranda. All validation reports, data packages, and review comments shall be retained as permanent project quality records in compliance with the *ERC Administrative Guidelines* (BHI 1995) and Section 6 of the *ERC Quality Program* (BHI 1997) requirements.

8.4 PROCESS FOR HANDLING UNACCEPTABLE OR SUSPECT DATA

The analytical data flow and data management process is described in detail in EIP Section 2, "Sample Management" (BHI 1996). Data errors or procedural discrepancies related to laboratory analytical processes shall prompt data requalification by the validator, requests for reanalysis, or other appropriate corrective action by the responsible laboratory as required by governing Sample Management or approved subcontractor data validation procedures. If sample holding time requirements are compromised, insufficient sample material is available for reanalysis, or any other condition prevents compliance with governing analytical methods and data validation protocols, the situation shall be formally documented on a Sample Disposition Record (SDG) per EIP 2.7, "Sample Disposition Record" (BHI 1996). If required, the incident will also be documented as a nonconformance in compliance with Section 3 of the *ERC Quality Program* (BHI 1997). If a Nonconformance Report is issued, corrective action shall be in accordance with Section 3 of the *ERC Quality Program* (BHI 1997), and brought to the immediate attention of the BHI technical lead and QA coordinator for their appropriate action. The same process (SDG) shall be used if problems are observed with validated data, either as part of the data assessment process described in Chapter 12 of this QAPjP or if separately observed by the operable unit manager; if the data have been entered in the Hanford Environmental Information System (HEIS), the HEIS data custodian shall be immediately notified in order that the data may be flagged (in compliance with EIP [BHI 1994a] and the *HEIS User's Manual* [WHC 1990b]) as

suspect, pending resolution of the nonconformance and completion of all required corrective actions.

9.0 INTERNAL QUALITY CONTROL

General procedures used in the field and laboratory to maintain data quality include the following:

- Use of accepted sampling and analysis techniques
- Justification and documentation of any actions contrary to accepted or specified techniques
- Documentation of pre-field activities, such as container preparation and instrument calibration
- Documentation of post-field activities including sample shipment and receipt, equipment check-in, and debriefing
- Documentation of quality control data
- Documentation of field and laboratory activities
- Generation of quality control samples.

All analytical samples shall be subject to in-process quality control measures in both the field and laboratory. Internal quality control checks for reference method analysis shall be as specified by the current statement of work, work orders for sampling activities, or in applicable EIPs; the number of quality control samples are shown in Table E-4.

9.1 FIELD QUALITY CONTROL CHECKS

The number of field quality control samples specified in Table E-4 are based on the following minimum requirements. These requirements are adapted from *Test Methods for Evaluating Solid Waste* (EPA 1986), as modified by the proposed rule changes included in the *Federal Register*, 1989, Volume 54, No. 13, pp 3212-3228, and 1990, Volume 55, No. 27, pp 4440-4445.

- Field duplicate samples. For each shift of sampling activity under an individual sampling subtask, a minimum of 5% of the total collected samples shall be duplicated, or one duplicate shall be collected for every 20 samples, whichever is greater. Duplicate samples shall be retrieved from the same sampling location using the same equipment

and sampling technique and shall be placed into two identically prepared and preserved containers. All field duplicates shall be analyzed independently to provide an indication of gross errors in sampling techniques.

- Split samples. Upon specific BHI or regulator request, and at the technical lead's direction, field or field duplicate samples may be split in the field and sent to an alternative laboratory as a performance audit of the primary laboratory. Frequency shall meet the minimum schedule requirements for audit procedures or the specific needs of the requesting organization.
- Blind samples. At the technical lead's discretion, blind reference samples may be introduced into any sampling round as a quality control check of the primary laboratory. Blind sample type shall be as directed by the technical lead; frequency shall meet the minimum schedule requirements for audit procedures.
- Field blanks. Field blanks shall consist of pure deionized distilled water, transferred into a sample container at the site and preserved with the reagent specified for the analytes of interest. Field blanks are used as a check on reagent and environmental contamination and shall be collected at the same frequency as field duplicate samples.
- Equipment rinsate blanks. Equipment blanks shall consist of pure deionized distilled water washed through decontaminated sampling equipment and placed in containers identical to those used for actual field samples. Equipment blanks are used to verify the adequacy of sampling equipment decontamination procedures and shall be collected at the same frequency as field duplicate samples where applicable.
- Volatile organic analysis trip blanks. The VOA trip blanks consist of pure deionized distilled water added to one clean sample container, accompanying each batch (cooler) of sample containers shipped to the sampling facility. Trip blanks shall be returned unopened to the laboratory and are prepared as a check on possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions. The trip blank shall be analyzed for volatile organic compounds only, as shown on EPA's target compound list (EPA 1991). In compliance with standard BHI procurement procedures, requirements for trip blank preparation shall be included in procurement documents of work orders to the sample container supplier and/or preparer.

9.2 LABORATORY QUALITY CONTROL CHECKS

Laboratory quality control data are necessary to determine precision and accuracy of the analyses and to demonstrate the absence of interferences and contamination of glassware and reagents. Unless otherwise specified in BHI-approved analytical methods, internal quality control checks performed by analytical laboratories shall meet the following minimum requirements.

- Matrix-spike/matrix-spike duplicate samples. Matrix-spiked samples require the addition of a known quantity of a representative analyte of interest to the sample as a measure of recovery percentage and as a test of laboratory accuracy. The spike shall be made in a replicate of a field duplicate sample. Replicate samples are separate aliquots removed from the same sample container in the laboratory. Spike compound selection, quantities, and concentrations shall be described in the analytical procedures submitted for BHI review and acceptance. One sample shall be spiked per analytical batch, or once every 20 samples, whichever is more frequent.
- Quality control reference samples. A quality control reference sample shall be prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range. Reference samples are required as an independent check on analytical technique and methodology and shall be run with every analytical batch, or every 20 samples, whichever is more frequent.
- Laboratory/method blank.

Other requirements specific to laboratory analytical equipment calibration are included in Chapter 6 of this QAPjP. For field screening gas chromatography (GC) analysis only, at least one duplicate sample per day or 1 duplicate per 20 samples, whichever is greater, shall be routed to a qualified laboratory as an overcheck on the proper use and functioning of field GC procedures and equipment. Duplicates shall be selected, whenever possible, from samples in which significant readings have been observed during field analysis. The minimum requirements of this section shall be invoked in procurement documents or work orders in compliance with standard WHC procedures as noted in Section 4.1.

10.0 PERFORMANCE AND SYSTEM AUDITS/ASSESSMENTS

Performance and systems audits will be performed regularly throughout the course of the activities addressed by the work plan; schedules shall be developed as required by their governing procedures. Additional surveillance may be scheduled as a consequence of corrective action requirements or may be performed upon request. All quality-affecting activities are subject to surveillance. All aspects of inter-operable unit activities may also be evaluated as part of routine QA program audits, pursuant to the requirements of the Section 9 of the *ERC Quality Program* (BHI 1997). Program audits shall be conducted in accordance with Section 9 of the *ERC Quality Program* (BHI 1997).

Systems audits/assessments consist of the evaluation of the components of the measurement systems to determine their proper selection and use. Systems surveillance requirements will be implemented according to the procedures in Part 2, Section 9.3 of the *ERC Quality Program* (BHI 1997), and QPP 3.1, "Surveillance" (BHI 1995).

After systems are operational and are generating data, performance audits/assessments will be conducted to ensure the accuracy of the total system or its individual parts. In a performance audit/assessment, known quantitative data are compared with data produced by the measurement system.

Any discrepancies observed during the evaluation of performance audit results or during system audit surveillance activities that cannot be immediately corrected to the satisfaction of the investigator shall be documented on a surveillance report and resolved in compliance with Part 2, Section 9.3 of the *ERC Quality Program* (BHI 1997), and QPP 3.1, "Surveillance" (BHI 1995).

11.0 PREVENTIVE MAINTENANCE

All measurement and testing equipment used in the field and laboratories that directly affect the quality of the field and analytical data shall be subject to preventive maintenance measures that ensure minimization of measurement system downtime and corresponding schedule delays. Laboratories shall be responsible for performing or managing the maintenance of their analytical equipment. Maintenance requirements, spare parts lists, and instructions shall be included in individual laboratory QA plans, subject to BHI review and acceptance as noted in Sections 2.1, 2.2, and 4.1 of this QAPjP. BHI field equipment shall be drawn from inventories subject to standard preventive maintenance and calibration procedures per Section 13 of the *ERC Quality Program* (BHI 1997). Field procedures submitted for BHI review and acceptance by participant contractors or subcontractors shall contain provisions for preventive maintenance schedules and spare parts lists to ensure minimization of equipment downtime.

12.0 DATA MEASUREMENT ASSESSMENT PROCEDURES

As discussed in Chapter 5, various uncertainty may exist in the variability of physical and chemical parameters used in the data characterization. Various statistical and probabilistic techniques may be used in the process of data comparison and analysis. *Soil Sampling Quality Assurance User's Guide* (Barth and Mason 1984) provides statistical techniques necessary to numerically assess the statistical uncertainty considerations and quality control checks which shall be routinely assessed for all sampling data. *A Rationale for the Assessment of Errors in the Sampling of Soils* (Van Ee and Blume 1989) also provides equations for estimating uncertainty of data. The statistical methodologies and assumptions to be used in such evaluations shall be defined by written directions that are signed, dated and retained as project records.

13.0 CORRECTIVE ACTION

Corrective action requests required as a result of surveillance reports, nonconformance reports, or audit activity shall be documented and dispositioned as required by Part 1, Section 3.2 of the *ERC Quality Program* (BHI 1997). Other measurement systems procedure or plan corrections that may be required as a result of data assessment or routine review processes shall be resolved as required by governing procedures or shall be referred to the technical lead for resolution. Copies of all surveillance, nonconformance, audit, and corrective action documentation shall be placed with the project quality records on completion or closure.

13.1 EQUIPMENT OPERATING RANGES

Instruments or equipment found to be operating outside acceptable operating ranges or found to be in use after the expiration of the calibration period must be investigated in accordance with the procedures specified in Chapter 6.

13.2 DEVIATIONS FROM PROCEDURES

Unplanned deviations from procedural requirements, either technical or administrative, must be documented and called to the attention of the technical lead. The report of the deviation must identify the requirement deviated from, the cause of the deviation, whether any data were affected, and the corrective action necessary to remedy the immediate problem and to prevent recurrence. Records of unplanned deviations must be maintained in accordance with EIP 1.1, "Preparing, Revising, and Cancelling Environmental Investigations Instructions" (BHI 1996). Planned deviations will be handled in accordance with EIP 1.1 (BHI 1996) or other applicable BHI document control procedures.

13.3 NONCONFORMING MATERIALS

Materials that do not conform to specifications must be handled as required by Part 1, Section 3.1 of the *ERC Quality Program* (BHI 1997). If appropriate, such nonconforming items must be segregated and tagged to identify their status pending disposition.

14.0 QUALITY ASSURANCE REPORTS

As previously stated in Chapters 10 and 13, project activities shall be regularly assessed by performance and system auditing and associated corrective action processes. Surveillance, nonconformance, audit, and corrective action documentation shall be routed to the project quality

records on completion or closure of the activity. A report summarizing all audit and surveillance activity (see Sections 4.4 and 13.2), and any associated corrective actions, shall be prepared by the QA coordinator at the completion of the investigation. Such information will become an integral part of the final field investigation report. The final report shall include an assessment of the overall adequacy of the total measurement system with regard to the DQOs of the investigation.

15.0 REFERENCES

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EPA, 1991, *USEPA Contract Laboratory Program Statement of Work for Organics Analysis: Multi-Media Multi-Concentration*, U.S. Environmental Protection Agency, Sample Management Laboratory, Washington, D.C.

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WHC, 1992, *Base Calibration of Pacific Northwest Laboratory's Gross Gamma Borehole Geophysical Logging System*, WHC-EP-0276, Westinghouse Hanford Company, Richland, Washington.

APPENDIX D

216-B-2-2 DITCH BOREHOLE DATA SHEET

General Information

One borehole will be completed in the 216-B-2-2 Ditch at the influent end of the ditch. The borehole Identification Number is B8079, and will be referenced as such in this document. The bore will be considered at total depth when the geologist determines the well is at, or immediately above, the water table.

Drilling

The well may be drilled using the cable tool drive barrel method, unless cemented formation or large boulders are encountered that necessitates the use of hard tools. Changing of the tools will require concurrence from the task leader and the technical representative.

Casing Requirements

The bore will be started with 10-inch casing at the surface, and this size will be maintained through the potential contamination, or to a depth of 40 feet, plus or minus 10 feet. The field team leader and the technical representative will determine when to reduce to the next smaller casing, with the aid of the geophysical logging and soil screening data. Casing reduction will be to 8-inch ID, which will be carried through the next 180 feet (about 220 feet bgs), or to perched water if encountered. Provided the 8-inch casing is continued to 220 feet, the field team leader, drilling contractor, and technical representative will determine whether the 8-inch casing can be taken to 250 feet, the bottom of the proposed bore. If perched water is encountered, the casing will be reduced to 6-inch ID, which will continue to the end of the hole.

Sampling

Sampling will be completed using the split-spoon sampling method. Chemical samples will be attained through the use of a split tube or core barrel; from below ground surface, the chemical sampling intervals are as follows, in feet: 5, 10, 12, 14, 20, 30, 40, 50, 75, 100, 150, and immediately above the static water level, at approximately 250 feet. Physical samples will be taken immediately below the chemical sampling intervals, and will be taken with a standard 5-inch split spoon with either Lexan™ or stainless steel liners.

Borehole Abandonment

Once B8079 is determined to be at depth, the bore will be abandoned. To ensure a proper seal along the capillary fringe of the aquifer, a bentonite and cement grout slurry will be tremied into the hole until a 25 foot lift is documented. The bore will then be filled with bentonite, and the remaining abandonment will be according to the *Washington Administrative Code*, Chapter 173-160 and industry standards, as approved by Bechtel Hanford, Inc.

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